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ABSTRACT

The use of computers in classrooms to support and extend instruction is a topic which is being discussed in major educational forums across the United States. Until a few years ago, computer use in schools was the exclusive domain of the mathematics department. Other content areas have now found ways to use computers to enhance their instruction. The purpose of this guide is to give teachers and supervisors a working knowledge of various approaches to enhance pupil learning. It demonstrates some of the many ways in which science departments can use microcomputers to assist teachers in teaching earth science. Computers can be used to enhance the learning process by assisting students in recording and categorizing data, formulating conclusions, and conducting experiments. The 36 activities in this guide are organized into four areas: (1) "Matter on Earth"; (2) "The Composition of the Earth"; (3) "The Atmosphere"; and (4) "The Earth in Space." Also included is a discussion of classroom management techniques and (in the appendices) a glossary, a diskette care guide, information about copying public domain software, a list of software used in this guide, and a list of five additional school district resource centers in the Greater New York Area. (CW)

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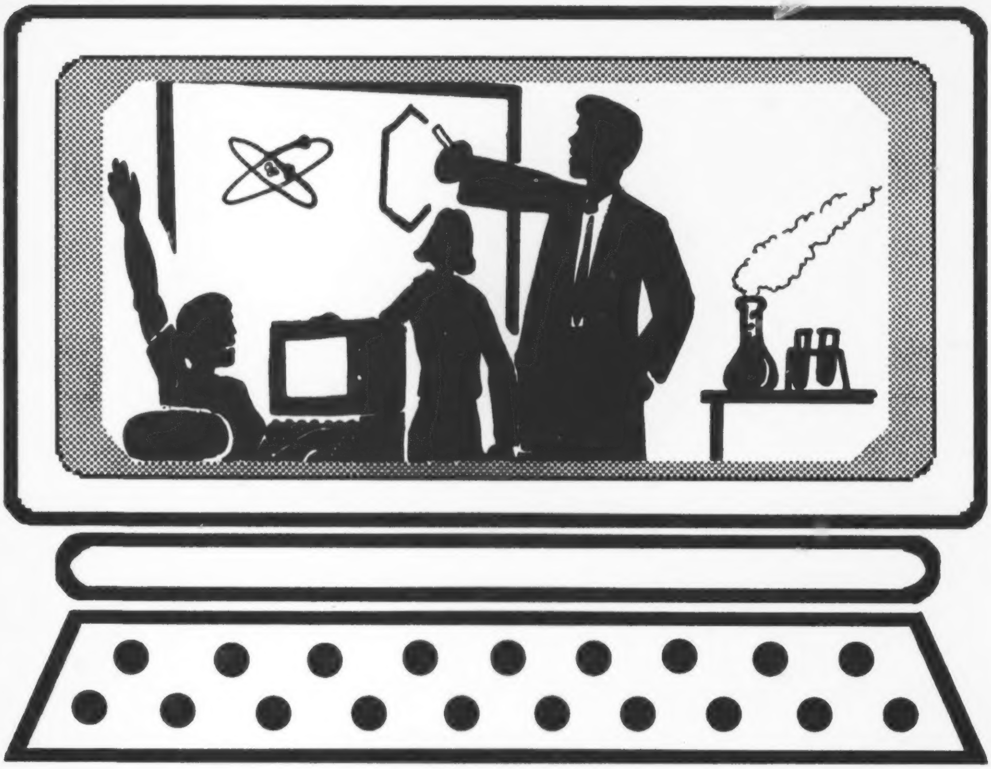
COMPUTERS IN THE EARTH SCIENCE CLASSROOM



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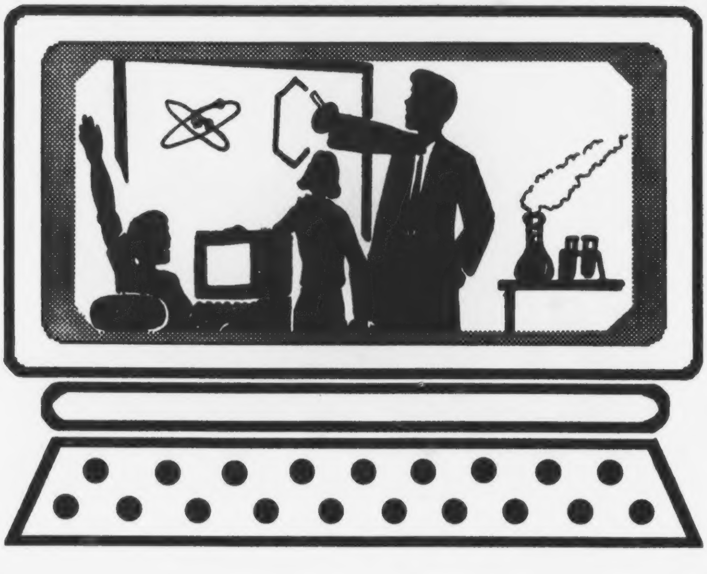

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Foreword

The use of computers in classrooms to support and extend instruction is a topic which is being discussed in major educational forums across the country. Until a few years ago, computer use in schools was the exclusive domain of mathematics departments. Now however, other content area departments have found ways to use computers to enhance the teaching of their subjects.

This guide demonstrates the many ways in which science departments can use microcomputers to assist teachers in teaching earth science. Computers can be utilized to enhance the learning process by assisting students in recording and categorizing data, formulating conclusions and conducting experiments. We are confident that this new technology will extend student learning in ways not possible before.

We hope that the suggestions and materials included in this guide will demonstrate and support the range of uses of the computer in earth science classes.

Charlotte Frank

Charlotte Frank, Executive Director
Division of Curriculum and Instruction

The use of computers in the classroom has become more prevalent during the past few years. Through this use we have developed a knowledge of their functions and a better vision of their potential. We encourage our colleagues to freely experiment and attempt new approaches. Only with all of us working in concert, can we fulfill our vision for an effective integration of school technology into all subject areas. From these beginnings, we will nurture the critical thinking and practical skills our students will need to succeed in the information age. If children are not comfortable with computers, they will be as unprepared for the future as an adult who cannot read or write.

The purpose of this guide is to give teachers and supervisors a working knowledge of various approaches to enhance pupil learning. Our guides are intended to be open ended and flexible in nature. As a 1920 car is not efficient by 1980 standards, outmoded computer education ideas of the seventies have been replaced by the new visions of the eighties. Classroom use of technology has doubled and redoubled in the past few years. Teachers are continually devising new ideas for the use of this technology.

Feel free to write to me directly with your comments and suggestions concerning this curriculum guide, so that we may improve and update it to meet your needs.

Irwin Kaufman

Irwin Kaufman, Director
Office of Technology

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Introduction

This book is designed to serve as a resource guide for teachers of earth science. It is intended that this guide be used as a supplement to curriculum materials already available from the New York State Education Department and the Division of Curriculum and Instruction of the New York City Board of Education.

Each of the topics in this guide represents an approach to the use of computers as an enhancement to regular earth science instruction. It is expected that teachers will "pick and choose" from among the various methods and approaches which are offered. In that sense, the book is a "sampler" of possible teaching techniques.

In no way is this book meant to represent a guide for an entire earth science course but rather a collection of possible alternative methods of teaching individual earth science topics.

Present plans call for the development of similar enhancement guides for other subject areas. We welcome your suggestions for future direction.

Preface: Why Computers?

"Be not the first by whom the new are tried,
Nor yet the last to lay the old aside."

Nothing could give us better advice concerning the integration of computers into traditional teaching methods than Pope's couplet from "An Essay on Criticism." In embracing the computer, we certainly run the risk of being "the first," of rushing to rely too much on a machine's ability to teach and review. And yet, given the power of the personal computer to educate, we run an equal risk of being "the last," of resisting too much and relying too little on its abilities as a teaching aid and, therefore, losing, and causing our students to lose, the help computers can give classroom instruction.

What are the computer's strengths? Even a short list must include these points:

1. Classroom computers allow students to work individually, and yet together, on synchronized exercises.

2. Computers require each student to focus attention narrowly; for many students they insure a closer understanding of the day's work.

3. Computers allow a greater immediacy of individual student response for a greater number of students.

4. Computers give students immediate feedback during the exercise phase of a lesson.

5. Computers afford students the opportunity to work at their own pace, rather than at the pace of an imaginary class median.

6. Computers give each student a more thorough contact with the subject matter as an individual or as part of a small group.

7. Computers afford absentees a far greater opportunity to catch up on missed work without disrupting the flow of classroom instruction.

8. Computers allow teachers to make more efficient use of their classroom time as compared with more traditional question and answer lessons.

9. Computers encourage student response in a nonjudgmental way, thus making the sometimes groping experience of learning less intimidating for students who are not always comfortable in a classroom setting. Computers never get tired of or exasperated with a demand for countless repetitions of the same instruction.

10. Finally, and, perhaps, most important, the computer has an intrinsic motivational quality that increases student interest, concentration, and retention; we cannot ignore the appeal working with computers has for today's students.

Every experienced teacher will recognize that, except for point 10, none of these points is new; in fact, they have been part of good teaching since time immemorial. And that recognition indicates an important point about the computer and the classroom. The use of the computer is not, strictly speaking, something revolutionary in education, but something evolutionary instead. It enhances, rather than replaces, those methods of teaching that have traditionally been recognized as the most effective. Its instructional function is not something entirely new, and, consequently, something to be looked upon with suspicion, but something old done in a new and, often, more effective way.

Classroom Management Procedures

Thirty-six students working independently at 16 or more computer stations can easily lead to an almost chaotic confusion during the computer lab period, particularly if finding and distributing each student's working diskette takes too much time at the start. In addition, your ability to retrieve the performance information the program will record for each student depends upon carefully organizing the distribution and collection of the diskettes from the start. For these reasons, and a host of others, it is a good idea to think of classroom management procedures long before the computer lab period actually takes place, and to structure both the computer period and the computer room in ways that will make the computer period run smoothly and effectively.

In an ideal world each of your students would be able to work independently at a computer workstation, and that situation may exist in some classrooms at some times during the year. But most classes consist of 30 or more students and most computer labs of 16 or fewer workstations; the large number of workstations and the larger number of students requires careful record keeping and classroom management. Students must work in a highly structured environment in the lab or they will accomplish much less than you expected them to.

The following outline of suggested procedures will help you create a structured computer lab; after a few periods in the lab, you'll be able to refine the procedures to better suit your own needs.

I. Before the computer lab period.

1. If you are not familiar with the computers in your school, or not entirely comfortable with them, try to spend some time working with them on your own before you guide your students in using them.

   Your uncertainty or uneasiness about computers may leave you at a loss at some point in your lesson or be transmitted to those of your students who also feel intimidated by the machine. In either case it will have a negative effect on your lesson.

2. Preview the software you intend to use thoroughly. Learn what it does and how it works. Find out what background information your students will need to run the program -- for example, what vocabulary they will have to know. Once 16 groups of students start working and, presumably, asking questions, it will be impossible to decipher anything about the program that you, and they, may find confusing.

3. Number each workstation in the computer lab clearly, so that you and the students can see the numbers easily.

If it isn't possible to copy one student working diskette for each member of the class, you can use one diskette at each workstation. However, the advantages of individual student diskettes outweigh the disadvantages, and by a wide margin. Diskettes are relatively inexpensive, particularly when they are ordered in large quantities, and you will be able to use them year after year, virtually forever, simply be recopying the original program diskette over them whenever a class completes the program. In addition, providing each student with a data diskette will prevent certain student generated errors from occurring and make classroom management and student evaluation much easier for you. Refer to the section of this booklet entitled "Copying Public Domain Diskettes for the Apple IIe and II Plus" for copying instructions and for information about obtaining blank diskettes through a New York State Supply contract.

4. Label each data diskette to coincide with one of the workstations -- i.e., diskette number 14 must always be used at workstation 14. (Of course, any diskette will work at any station, but for classroom management purposes follow this rule.)

5. Divide your class into workstation groups of two, three, or four students, as needed. Look over the student combinations carefully before making final assignments. If you don't feel that a particular combination of students will work well together for an extended period of time, don't allow them to form a group. Once a group has been established, it will be necessary for those students to work together through each of the modules in the program on subsequent days, a procedure that can last for weeks.

6. Assign each group a work station number and keep a close record of the names of the group members and their group number. Each group should work at the same workstation through the entire program, and with the same student operating diskette. Each student data diskette will eventually hold all of the records of only those students who use that diskette. If a student uses a different diskette each work period, the records will be scattered among them all, and it will be difficult to retrieve them; for 30 or more students it would be too time consuming to be feasible.

7. As an extra precaution, label each data disk with the names of the students who will use it.

II. During the computer lab period.

1. At the beginning of the period have the students sit at their assigned workstations, with no exceptions. Then distribute the diskettes according to their corresponding numbers; the student names on the diskettes should also correspond to the students who are at each workstation.

2. At the end of the period collect the diskettes and store them in numerical order to make their distribution at the next period easier.

3. Once you have established workstation groups, assignments, and procedures, resist any temptation to make changes unless the changes will clearly be to your advantage. As in any classroom, the closer you follow established procedures, the more control you will maintain over the period and the more effective the use of the software will be.

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I

Matter on Earth

TOPIC 1 - The Nature of Matter

Aim: How are the three states of matter different from one another?

Performance Objectives: Students will be able to:

- define matter
- identify a given sample of matter as a solid, liquid or gas
- explain how the three states of matter differ from one another in terms of distance between molecules

Materials:

- beaker of ice
- graduated cylinder full of water
- beaker of boiling water
- bunsen burner
- ring stand with one ring and wire gauze
- beaker filled with marbles

Motivation:

Display beaker of ice, cylinder full of water and beaker of boiling water on the ring stand. Tell the class that the ice, water and steam are all composed of the same substance.

Elicit the question: Why do they appear to be different?

Development:

1. How would you compute the VOLUME of an ice cube? (L x W x H)

2. Why can't you compute the volume of the WATER in this manner? (Water has no permanent shape.)

3. Why does this sample of water seem to have a cylindrical shape? (It is in a cylindrical container.)

4. Have a student read the volume of the water on the side of the graduated cylinder. Establish that both ice and water have a definite volume, but water has no permanent shape.

5. Why can't we calculate the volume of STEAM? (Draw attention to the fact that steam expands to fill any space open to it. Hence it has no permanent shape or definite volume.)

6. Summarize the findings on the board. (ICE has a permanent shape and a definite volume. How are WATER and STEAM different from ice in this respect?)

7. Have students look up the definition of MATTER in their textbooks. Explain that ice, water and gas represent the three STATES of matter:

SOLID -- Definite volume, permanent shape
LIQUID -- Definite volume, no permanent shape
GAS -- No Definite volume, no permanent shape.

8. Put the following list of substances on the board. Have students write the state of matter represented by each one.
   a) alcohol
   b) air
   c) coal
   d) iron
   e) gasoline*
   g) helium

*Gasoline, commonly called "gas", is actually a LIQUID. Its name is derived from the fact that it is a liquid that readily changes into a gas.

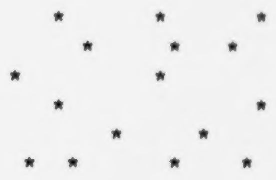
Display the beaker full of marbles. Compare the marbles to MOLECULES of water. Spill a few marbles out onto the demonstration table and allow them to roll away from each other.

- How is this similar to what is happening in the boiling beaker? (Which marbles represent steam and which represent water?)

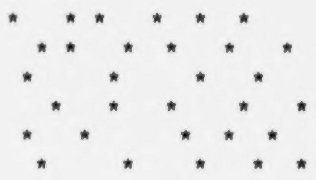
- How are the molecules of steam different from the molecules of water? (The molecules of steam are further apart.)

Put the following diagrams on the board:

MOLECULES OF A GAS



MOLECULES OF A LIQUID



- How would the molecules of a solid look? (Have a student volunteer draw the appropriate diagram on the board.)

Summary:

How are the molecules of solids, liquids and gases different from one another?

SOLIDS -- The molecules are close together
LIQUIDS -- The molecules are further apart
GASES -- The molecules are very far apart.

Assignment:

1. What are the three states of matter?
2. Explain one way in which a solid is different from a gas.
3. How are the molecules of a liquid different from those of a solid?

TOMORROW: Tell students that tomorrow's lesson will be held in the Computer Lab. Review the appropriate procedures and regulations as given in the beginning of the manual.

TOPIC 2 - The Nature of Matter (Computer Lab)

Aim: How does matter change from one state to another?

Performance Objectives: Students will be able to:

- compare the three states of matter with reference to energy and motion of molecules
- identify a given change in state as evaporation, condensation, melting or freezing.

Materials:

- computer lab with 16 Apple Computers
- 16 copies of EXPLORING MATTER (D.C. Heath)
- class set of worksheets

Motivation:

Tell the class that the computer can show how molecules behave differently in the three states.

Development:

1. Escort the class to the computer lab and have the students take their assigned stations (usually two students to a computer). Explain that the program requires the use of three keys; the ESC key, the SPACE BAR, and the RETURN key. Check to see that all students are able to locate these keys.

2. Distribute one program to each group of students. Give them the following instructions to "boot" the system:

   a) put the disk in the disk drive with the label facing upward
   b) turn on the monitor (Show switch in front)
   c) turn on the computer (Demonstrate how to find switch in back)

3. Several screens of text will appear one by one. The final screen will say:

```
                            TEACHER DISK


                  You can use the TEACHER DISK to
                    RUN ------------------------
                    DESIGN ----- (Text) --------
                    COPY -----------------------

            To pick, use SPACE BAR  and then RETURN.
                     * * * *
                     * RUN *  DESIGN    COPY
   (Gold frame) ---->* * * *
```

4. Students should make sure that the gold frame is around the word, RUN. If not, they should move it with the space bar. Then they should press RETURN. The next screen will tell them to press the SPACE BAR. The screen that follows will say:

```
                    Welcome to
                 EXPLORING MATTER
             --------------------------
             --------------------------
             -------- (Text) ----------
             --------------------------
             --------------------------
      To start, put a student disk in Drive 1.
                Then press RETURN.
```

4. Instruct the students to remove the disks from the drive and re-insert them with the label facing downward, then press RETURN.

5. The next screen will say MAIN MENU and have two entries: MOLECULAR WINDOW and DICTIONARY. Students should move the gold frame to DICTIONARY by pressing the space bar once, then press RETURN.

6. The screen will display the DICTIONARY MENU with seven entries. This lab will use two of the entries: SOLID-LIQUID and LIQUID-GAS. Instruct students to move the gold frame to SOLID-LIQUID and then press RETURN.

7. Allow the students to view the program at their own pace (five minutes is sufficient time). At the end of this program, the screen will direct the student to press ESC. This will bring back the DICTIONARY MENU.

8. Before going on to LIQUID-GAS, have the students answer the following questions:
   a. How is the motion of molecules in a liquid different from the motion of molecules in a solid?
   b. How does a solid change when it MELTS?
   c. How does a liquid change when it FREEZES?

9. Have students view LIQUID-GAS by using the space bar and the RETURN key, as they did with the first program. Afterward, ask the following questions:

   a. What does CONDENSATION mean?
   b. How does the motion of the molecules change when a gas condenses?
   c. In which state do the molecules of a substance have the greatest amount of energy (heat)?

10. Have the students shut down their computers by doing the following:

   a. Remove the disks and replace them in their sleeves.
   b. Turn off monitor.
   c. Turn off computer.

Summary:

Have students complete the worksheet for this lesson.

Assignment:

1. Why must you keep ice cubes in the refrigerator?

2. How does the motion of the molecules change when a liquid freezes?

3. How does the amount of energy in the molecules of a gas compare to the amount of energy in the molecules of a solid?

GRADE 8 (Earth Science)
Unit I, Lesson 1a.

STUDENT'S NAME ____________________________ CLASS ______ DATE________

WORKSHEET

PART I: Read the passage below and answer the questions by writing complete sentences or by filling in the blanks with SOLID, LIQUID, or GAS.

A girl took a container of ice cream from the freezer and left it on the kitchen table. An hour later she returned to the kitchen and found that all the ice cream was ruined.

1. The ice cream had changed from a ___________ to a ____________.

2. How did the distance between the molecules change?

3. How did the amount of energy in the molecules change?

4. Is this an example of FREEZING, MELTING, CONDENSATION or EVAPORATION?

PART II: Fill in the blanks with SOLID, LIQUID or GAS.

1. Molecules are closest together in the ________ state.
2. Molecules move fastest in the _________ state.
3. Matter that has a definite volume and a permanent shape is a ________.
4. Molecules are said to "slide" over one another in the ____________state.
5. When matter CONDENSES, it changes from a ________to a _____________.
6. When matter EVAPORATES, it changes from a ________to a _____________.

TOPIC 3 - The Building Blocks of Matter

Aim: What are the building blocks of matter?

Performance Objectives: Students will be able to:

- define element as a substance that cannot be broken down into simpler substances by ordinary means
- state that different substances have different properties
- list the observed properties of a given substance

Materials:

- Hoffman apparatus
- two test tubes
- splints
- matches
- safety goggles
- test tube holder

Motivation:

Allow the Hoffman apparatus to operate for a few minutes in front of the class. Elicit the question: Why is it forming bubbles?

Development:

1. Draw off the hydrogen from the cathode side of the apparatus (The hydrogen is the gas whose volume is twice as large as the other gas). Keep the test tube inverted, since hydrogen is considerably less dense than air. Insert a flaming splint into the tube and have the students record the observed result.

Caution: When performing this demonstration, be sure to observe all the prescribed safety regulations.

2. How do we know that this substance is NOT water? (Introduce the term, PROPERTIES).

3. How are the properties of this substance different from water? Have students list the properties they observed. Asking, "Why did I have to hold the tube upside down?", may elicit the fact that the gas is less dense than air.

4. Draw off the oxygen from the anode side of the apparatus and keep the test tube rightside up (Pure oxygen is slightly denser than air). Insert a glowing splint into the tube and have the students record the observed result.

5. How are the properties of this gas different from the first one? Explain that the first gas is called HYDROGEN and the second gas is called OXYGEN. So far, the class has seen three different substances; water, oxygen and hydrogen.

6. How can you tell the difference between two substances?
   (Different subtances have different PROPERTIES.)
   At the beginning of this lesson, there was only WATER in the apparatus.
   Why is there hydrogen and oxygen there now?
   Elicit the following word equation from the students:

   WATER -------> HYDROGEN + OXYGEN

7. What was the Hoffman apparatus doing to the water?
   (Breaking it down into hydrogen and oxygen)

8. Explain to the class that if we put hydrogen or oxygen into the Hoffman apparatus, they do not break down, but remain as they are.

9. How is WATER different from these two substances?
   (Water can be broken down. HYDROGEN and OXYGEN cannot).

10. Explain that certain substances, like hydrogen and oxygen, are classified as ELEMENTS, while other substances, such as water, are not. Have students attempt to write a definition of ELEMENT, based on what they observed.

11. Write the chemical equation for water on the board: H_2O.
    Why is it written with an H and an O?

12. Call attention to the volumes of the two gases in the Hoffman apparatus.
    Why is there a "2" after the H?
    (Water has twice as much hydrogen as oxygen).

13. Put the formula for carbon dioxide on the board: CO_2.
    Why is this substance not considered an element?
    What are the two substances into which it can be broken down?

14. Have the students look up the number of known elements in their textbooks.
    Explain that there are thousands of known substances.
    How can we get so many substances from just 106 elements?
    (Many substances are composed of two or more elements).

Summary:

Have students write an answer to the question: "Why are elements called the building blocks of matter?"

Assignment:

1. How can you tell one element from another?

2. State three properties of the element IRON.

3. Why isn't water considered an element?

TOPIC 4 - The Properties of Elements

Aim: Why are elements classified as metals and nonmetals?

Performance Objectives: Students will be able to:

- list three differences between metals and nonmetals
- define the terms, malleable, ductile and luster.

Materials: Copper, Carbon (charcoal), Iron, Lead, Iodine, Mercury*, Sulfur, Aluminum, Hammer, Two pliers, Bunsen burner, Electric circuit with light bulb and switch.

Motivation:

Tell the class that the 106 elements are classified in two groups; 84 in one group and 22 in the other. Elicit the question: Why are they put into these two groups?

Development:

Display all the samples except mercury on the front table. Have a volunteer try to separate the samples into two groups. Ask the student how he/she determined in which group to put each element.

Shine a flashlight on the aluminum, and then on the carbon.

- How did the two elements react differently to the light?

Introduce the term, LUSTER and have a student volunteer classify the samples as to the presence or absence of this property. The student will put lead into the non-luster group. Explain that lead actually belongs in the other group.

Strike the lead and the copper with the hammer.

- How did the hammer change the samples?
- How would the hammer change the carbon? (Do not actually perform this demonstration, as it may result in flying chips.)

Elicit the difference between MALLEABLE and NON-MALLEABLE. Demonstrate the DUCTILE quality of metal by heating the copper over the bunsen burner and elongating it with the two pliers.

Why is lead classified with copper, iron and aluminum even though it has no luster? (It is both malleable and ductile.)

Demonstrate the electric circuit by closing the switch and turning on the light. Leave the switch open and lay the piece of copper across the two ends of the switch. Repeat the demonstration with the piece of carbon. Have students record their observations.

*Caution: Mercury is a poisonous substance. It should be kept in a sealed bottle and used for display purposes only.

-What is another difference between these two groups of elements? (One group conducts electricity, the other does not.)

Turn on the bunsen burner again. Ask for a volunteer to hold one end of the iron bar and keep the other one in the flame. Ask them why no one is volunteering.

-What else, beside electricity, can these elements conduct?

Put the following on the board:

GROUP A	GROUP B
Copper	Sulfur
Iron	Carbon
Aluminum	Iodine
Lead	

Have the students write three differences between the elements in GROUP A and the elements in GROUP B. Explain that the elements in GROUP A are called METALS and the elements in GROUP B are called NONMETALS.

Show the bottle of mercury.

1. How is this element different from the other seven?

2. Why would it be classified as a METAL?

Summary:

1. What are the properties of a METAL?

2. What are the properties of a NONMETAL?

Application:

1. Why is the reflector in this flashlight made of metal? (Luster)

2. Why is electrical wire made of metal? (Conductivity and Ductility)

3. Why is a cooking pot made of metal, while the handle is made of wood?

4. Why is iodine classified as a nonmetal even though it has a slight luster?

Homework:

1. Define the terms malleable and ductile.

2. How do metals and nonmetals differ with respect to conductivity (the ability to conduct energy)?

3. If you were given a sample of an element, how would you determine if it is a metal or a nonmetal?

TOPIC 5 - Elements Combine With Each Other

Aim: How do elements form new substances?

Performance Objectives: Students will be able to:

- state that elements can combine to form new substances called compounds
- explain that the properties of a compound are different from those of the original elements
- list two differences between a given compound and its component elements

Materials:

- steel wool
- bunsen burner
- triple-beam balance
- ceramic block
- magnet
- electric circuit with light bulb and switch
- chemicals: copper, sulfur, copper sulfide.

Motivation:

1. Display a lump of steel wool.

2. Tell the class that this object is made of a certain substance, but it can be changed into a different substance.

3. Elicit the question: How can we change into a different substance?

Development:

1. Identify the main substance in the steel wool as iron. Demonstrate its conductivity, its malleability and its magnetism. Have students list the properties of iron.

2. How do you know that this substance is a metal? (Students should be able to identify the metallic properties.)

3. Place a ceramic block on the triple-beam balance and determine its mass. Place the steel wool on the ceramic block and determine the total mass of the block and the steel wool. Have the students determine the mass of the steel wool alone by the following formula:

   (MASS OF STEEL WOOL) = (TOTAL MASS) - (MASS OF CERAMIC BLOCK).

4. Leaving the ceramic block on the balance, pick the steel wool up with the tongs and heat it, using the bunsen burner on a low flame. After a few seconds, the steel wool should begin to glow red.

5. Extinguish the burner and hold the steel wool over the ceramic block, so that any fragments that fall off land on the block. Blow on the steel wool to make the red glow more intense. Continue holding the steel wool in the tongs until it has been completely burned.

6. Place the steel wool back on the ceramic block and have students note its new color, lack of magnetism and tendency to crumble.

7. How do you know that the steel wool has changed into a different substance? (It now has different properties.)

8. Why did we need air to form this new substance? (Elicit that burning requires OXYGEN.)

9. Identify this new substance as IRON OXIDE and put the following word equation on the board:

   IRON + OXYGEN -------> IRON OXIDE

10. Before the demonstration we had two separate substances: iron and oxygen. How have they changed now? (They have formed a new substance.)

11. Determine the mass of the steel wool again. Compare this new mass with the original mass. (The new mass should be slightly higher.)

12. Why is the mass higher now? (The iron combined with oxygen.)

13. Explain that a substance formed by the combining of elements is called a COMPOUND.

14. Display samples of copper and sulfur (two elements), and a sample of copper sulfide (a compound).

15. How can we form this compound? (By combining the two elements.)

16. How does this change the properties of the original elements? (Have students list the observed differences.)

17. Recall from yesterday that iron and copper are metals, and oxygen and sulfur are nonmetals.

18. How does a metal form a compound? (By combining with a nonmetal.)

19. WATER is a compound formed by combining the elements, hydrogen and oxygen. How is it different from iron oxide and copper sulfide? (Oxygen and hydrogen are both nonmetals.)

Summary:

Have students write an answer to the question; How does the formation of a compound affect the properties of the original elements?

Assignment:

1. What is a compound?
2. If you know the properties of two elements, how can you tell when they have combined to form a compound?
3. How are the properties of water different from the properties of oxygen and hydrogen?

TOPIC 6 - Properties of Mixtures

Aim: How do substances form a mixture?

Performance Objectives: Students will be able to:

- explain that a mixture retains the properties of the substances that compose it
- state that a mixture can be separated by physical means
- explain the difference between the formation of a mixture and the formation of a compound

Materials:

Iron filings, Sulfur powder, Paper, Magnet, Crucible, Tongs, Bunsen burner.

Motivation:

Display two samples on the table;

SAMPLE A -- A mixture of iron filings and sulfur.
SAMPLE B -- Iron sulfide

Have students indicate the observed differences between the two. Then explain that both samples are composed of the SAME two elements. Elicit the question: Why are the two samples different?

Development:

1. Put the bar magnet on the table and place the piece of paper over it. Pour some iron filings on the paper and have the class note the pattern formed. Do the same with the sulfur, and finally with SAMPLE A.

2. How do you know that there is iron in SAMPLE A? (The sample displays magnetism.)

3. Identify sulfur as the other component of SAMPLE A. Why does SAMPLE A have a grayish-yellow color? (The iron is gray and the sulfur is yellow).

4. Bring the magnet near SAMPLE B to show its lack of magnetism. How is SAMPLE A different from SAMPLE B? (Lack of magnetism, different color)

5. Review (from the previous lesson) the effect of compound formation on the properties of the original elements.

6. If SAMPLE B is made of iron and sulfur, why are its properties unlike those of either element? (The elements have combined to form a compound.)

7. Identify SAMPLE B as the COMPOUND, iron sulfide, and SAMPLE A as a MIXTURE of iron and sulfur. Compounds and mixtures are both formed by combining two or more substances.

8. Mix a small quantity of iron and sulfur in a crucible. Compare this with both samples and have students identify it as a MIXTURE. Heat the mixture by holding the crucible over a bunsen burner with the tongs. (Caution: Make sure the room is adequately ventilated.)

9. After the mixture bubbles for a short time, remove it from the heat and allow it to cool. Compare it again to both samples.

10. How do you know that the two elements have formed a COMPOUND? (They now have new properties, which are similar to those of SAMPLE B.)

11. Have students write an answer to the following question; How is a mixture different from a compound? (A compound has properties that are different from the original substances. In a mixture, the substances retain their original properties.)

12. Put the following word equation on the board;

IRON + SULFUR -----> IRON SULFIDE
(Two substances)   (A new substance)

How is the formation of a mixture different from this? (No new substance is formed.)

13. Identify the formation of a compound as a CHEMICAL change (a change that forms a new substance) and the formation of a mixture as a PHYSICAL change. (A change in the form or state of a substance; no new substance is formed.)

14. Display the magnet and SAMPLE A. How can we separate the two substances? (Have a volunteer demonstrate.)
Is that a physical change or a chemical change? (Have students give reasons for their answers.)

15. Try the magnet on SAMPLE B. Why doesn't it separate the substances in the compound? (The iron is no longer magnetic.)

16. Recall the Hoffmann apparatus that separated water into its component elements. How do you know that was a CHEMICAL change? (The water changed into two other substances)

Summary:

. How is separating a mixture different from separating a compound? (Separating a compound requires a chemical change, while mixtures can be separated by physical means.)

Application:

Mix some sugar into a glass of water. Have students identify this as a mixture or a compound. Have them justify their answers by listing the properties that are retained by the mixture.

Ask students how they might separate the two substances. Does this require physical means or chemical means?

Assignment:

1. How is a mixture of two substances different from a compound formed by the same two substances?
2. Why is the formation of a mixture considered a physical change?
3. How can a mixture be separated?

II

The Composition of the Earth

TOPIC 7 - Continental Drift

Aim: What evidence suggests that the continents were attached at one time and have since drifted apart?

Performance Objectives: Students will be able to:

- name and locate the seven continents
- list four types of evidence to support the theory of continental drift.
- define Wegener's theory of continental drift

Materials:

Hardware: 17 Apple (64k RAM)/IBM (128K RAM)/Tandy (128K RAM) computers with a single disk drive and color monitor

Software: Prentice-Hall courseware, Lab Pack, (consisting of 17 sets of 2 double sided disk), Cost $250.00, Earth Science Series, Continental Drift

Teacher's guide: Reproduce activity 1, (pages 12, and 13) for each students

Prerequisite Knowledge and Precaution:

1. Use of the computer laboratory requires established procedures for both the teacher and students.

2. It is strongly suggested that the teacher experience the software before the computer laboratory with his/her class

3. Ideally, individual computer and monitor switches should remain in the on position, thus allowing their control (on/off) from the main power panel located in each room.

4. The software should be loaded into the (A) disk drive, while the power is off, before the arrival of the class to the computer laboratory. During the computer lesson it will become necessary to reverse or exchange disks in each disk drive.

5. This activity should be performed by a person (paraprofessional, teacher or student) trained in the handling of the disks and operation of the disk drive. Provisions must also be made for the security and accountability of the courseware disks.

6. Before the end of the computer laboratory lesson, while each student is at his/her station, all computer disks should be collected and accounted for.

7. The way in which you use this program will depend on your student's needs. No prerequiste knowledge of the subject matter is required. To use the software to its fullest extent, class time should be appropriated for learning the operation of the software. Each program may be used in any one of the ways outlined below.

8. To introduce a concept in a motivating way before students read their textbooks. Lower-ability students may benefit especially from this initial presentation. To review a concept after textbook study or before a test. To extend and enrich a concept in the textbook.

9. To explore a concept in depth, using not only the software, but also the discussion questions and activity sheets provided in the software teacher's guide.

Overview:

Students begin the section by constructing a map of the world, then they begin to examine the evidence that led to the theory of continental drift. Students fit continents together to observe how shape is an example of evidence for the theory. Next students see how fossils provide evidence that the continents were once joined. The next pieces of evidence are rock similarity and the existance of ice sheets on many of the continents. After examining these four examples of evidence, the students conclude that the continents once formed a single landmass that Wegener called Pangaea. Review and check-up questions complete the lesson.

Motivation:

Show the class a map of the world. Ask:

1. If the seven continents were parts of a jigsaw puzzle, which continents would appear to "fit" together.

2. If you tape together a torn picture, what indicators do you use to make sure the picture is in the correct position before it is taped together?

3. As an earth scientist, what evidence may indicate to you that the continents of the earth were once connected together?

Development:

1. When the computer lesson starts, the teacher now assumes the position of a facilitator. He/she should walk around the room suggesting and helping students to understand what they are experiencing. If students are left to their own devices, some students will tend to become button pushers. They will push buttons until they have completed the lesson with little or no understanding of the concepts presented to them. A worksheet is a good device to help student participate in the computer lesson and a method for the teacher to measure the degree of learning experienced by the students.

2. A plastic reference card comes with the courseware. Read the side of the card entitled "BEFORE YOU START" first, then read the side entitled, "FOR THE STUDENT". Insert the disk with side one up. turn on the power. Wait for the program to boot up. The next key that must be pressed appears in the lower right hand corner of the screen.

3. You should see "ret", this means to press the "return" key. If you wait too long the computer will advance through the first two screens automatically and wait at the "PIE" ("P" review, "I" instruction, "E" evaluation) screen until you press a key

MAIN MENU

- If you have not used Prentice-Hall Courseware before, you should first go to the "Preview section" by pressing the letter "p". This action will place you in the preview menu.

PREVIEW MENU

HOW TO GET HELP

- Using the plastic instruction card as a reference, when you are at the Preview menu, press the number 1 key (How to get help). You are now at the "Help menu" screen. The purpose of this menu is to provide instruction assistance for the students in the use of the courseware and directional assistance for the students in maneuvering through the courseware.

HELP MENU

- The "G" key allows the student to use the glossary (at anytime or place in the courseware) while the "R" key allows the student to review the last sequence of instructional material in the courseware. The "K" key presents the keys that help the student maneuver through the courseware, while the "I, W, and X" keys allows the student to move about the courseware.

MEANING OF SYMBOLS

- The "2" key in the preview menu presents the same keyboard symbols that can be viewed by pressing the "K" key in the help menu. If you already have previewed this section, you may want to skip over it by going to the help menu.

VOCABULARY AND GLOSSARY

- The "3" key in the preview menu presents the vocabulary words that are accessible through the use of the disk glossary. Encourage the students to use the glossary when they are using the instructional section of the courseware. Require them to obtain the definition of these words or use them in complete sentences.

SCIENCE SKILL

- The "4" key in the preview menu presents a "science skill," which is an activity that students will be required to use in the second part of the instructional program. This part of the courseware is misplaced and should be omitted at this point. This activity will appear again in its proper context in the second part of the instructional program.

SUMMARY OF PREVIEW AND HELP MENUS

1. The preview and help menus of the courseware are analogous to the skills necessary to fully use the many facets (table of contents, index, glossary, units and chapters) of a textbook.

2. This is an important part of the courseware. The same keys are used in the entire Prentice-Hall series of courseware, and sufficient time (between 10 and 30 minutes, depending upon the ability and experience level of the class) should be devoted to the mastery of this part of the courseware.

3. Additionally, the teacher should either provide printed copies of the help menu or place the menu on the dustless chalkboard to allow the students to copy it into their notebooks for future reference. Remember, while using the instructional section of the courseware, the "Esc" key must be pressed to access the help menu.

4. Tell the students that when pressing a key on the computer keyboard, they should only press it once and then be patient until the computer responds. The computer "remembers" each and every time a key is pressed and will respond to it.

5. If an impatient student presses a key five times, in the hope of speeding the computer's response, the computer will respond as if the key was pressed five separate times. This action usually results in the computer moving too quickly through the next five screens of the courseware for any learning to occur.

6. This particular disk has three separate lesson. Each lesson is composed of several sections or sequences. While it is possible to start any of the three lessons at any time, you can only start a particular section or sequence within a lesson when its logical position in the lesson is reached or, you can review a particular sequence while the same particular sequence is being experienced on the computer.

7. You cannot, starting from the beginning of a lesson, jump over sections or sequences in each lesson. Therefore, plan your lessons with sufficient time to complete an entire lesson in a single sitting in the computer laboratory.

8. Now that you and your class have become familiar with the structure and operation of this particular series of courseware, we can commence with the lesson.

9. At the "PIE" menu, press the "I" key.

10. At the "Instructional" menu press the "I" key.

11. Have your assistants open the (A) disk drive door, remove the disk, flip it over to the number two side, re-insert the desk into drive (A), close the disk drive door and press the "return" key.

12. Screen number 1. This states the objective of the lesson while showing a present-day mercator projection map of the earth on the screen.

Suggest to the students that they write the objective into their note books. Review the continents and their names.

13. Screen number 2. Defines the term CONTINENTAL DRIFT. Notice that the term, continental drift, on the screen is in reverse (the normally white characters on a black background are now black characters on a white background), this indicates that the term in reverse is a term that has been defined in the courseware's glossary.

14. Let's use the glossary: press the flowing keys, "Esc", and "G". Notice that the instructions in the lower right hand portion of the screen show the up and down arrow keys with the words, "make a choice".

15. By using the arrow keys the blue rectangle can be moved around any term on the screen. Try it! When you have placed the blue rectangle around the term you wish to define, press the "return" key.

16. The explanation of the term you have requested appears on the screen. Suggest that the students write this term in their notebooks. Answer the question in the lower right hand part of the screen. Either you will continue to request definitions of terms or you will be returned to where you were last in the instructional section of the courseware.

17. Screen number 3. This screen displays, using animation, the continents drifting on the earth's surface.

18. Screen number 4. This screen shows only the continent of North America and asks the students to place each of the other continents in their correct relative positon. Have some type of reference materials (globe or world map) available for the students to research the correct answer.

19. Use the down arrow key to move each continent, one at a time, to the correct position relative to the North American continent. After the best positon has been reached, press the "return" key to verify its correct postion. Repeat this procedure for each continent. Suggest to students that they draw and label their correct maps into their notebooks.

20. Screen number 5. This screen shows the complete present-day map of the world. The blinking "ret" in the lower right hand corner of the screen signals the end of a sequence and offers a chance to again review this section or sequence of the courseware. The students enjoy repeating this sequence of the animation of the continents drifting and the chance to correctly place all of the continents in their correct relative positions to each other. Press the following keys to re-experience this sequence: Esc and R.

21. Screen number 6. Notice that the term "evidence" is in reverse, a signal that its definition can be located in the courseware's glossary. Suggest to the class that they write the definition into their notebooks. discuss the difference between the terms evidence and proof. Ask the class to look at the picture of South America and Africa, in the upper left hand part of the screen. Ask them to if they "see" any evidence of continental drift in that picture.

22. Screen number 7. Use the down arrow to select the correct choice to the question, "which of the following is evidence that the continents were once joined?" Remind the students to select the choice that answers the question rather than simply stating a fact.

23. Screen number 8. The student is now given control to manipulate the two continents so as to "fit" them together. Press the "space bar" to move the continents. When "fit" appears best, press the "return" key.

24. Screen number 9. Verifies the choice selected.

25. Screen 10. This screen introduces the term "continental shelf" and its definition. Notice that the term is in reverse, a signal that the term is further defined in the courseware's glossary, which can be accessed at this time if you so desire. Suggest that the students write the term in their notebooks. Discuss the term "submerged."

26. Screen number 11. Shows the "fit" between the edges of the continental shelves of each continent.

27. Screen number 12. Using animation, the close fit between the continents is shown.

28. Screen number 13. Highlights the fits between the continents and lists our first example of evidence, SHAPE, which suggests that they were once joined.

29. Screen number 14. We now move to the second example of evidence. Notice that the term "fossil" is in reverse. Review these terms: Fossils, east and southwest.

30. Screen number 15. Asks that a conclusion be drawn from this evidence. Use the down arrow key to make a selection. Discuss the term "reptile".

31. Screen number 16. Verifies the correct choice, shows how the continents were thought to be joined and highlights these area on the world wide map.

32. Screen number 17. Highlights the areas of the two continents where rocks of similar age and composition where found. What conclusion can be drawn from their location on each continents?

33. Screen number 18. Asks the students to draw a conclusion.

34. Screen number 19. Shows how the rocks were formed on a single landmass.

35. Screen number 20. Shows how three mountain ranges on three continents are related.

36. Screen number 21. List the third example of evidence, SIMILARITY OF ROCKS AND LOCATION.

37. Screen number 22. Introduces the term "Ice Sheet", in reverse, asking the students to select its location. Review the terms: equator and polar. Select either the A or B key.

38. Screen number 23. Verifies the correct answer.

39. Screen number 24. Shows the location where evidence of previous locations of ice sheets were found. What conclusion can be drawn?

40. Screen number 25. Ask to select a conclusion. Press the A or B key.

41. Screen number 26. Shows according to the past location of the ice sheets how it was thought that the continents were joined. The fourth example of evidence is now listed, ICE SHEETS. These common areas of the world are highlighted on the map.

42. Screen number 27. Lists and shows the location of all four examples of evidence of continental drift. Pick the correct conclusion using the N or Y key. Discuss the term "supercontinent."

43. Screen number 28. Introduces the students to the originator of the theory of continental drift, Alfred Wegener and the supercontinent of PANGAEA, which is shown in reverse. Notice that the "ret" is blinking, signaling the end of a sequence, which could be repeated at this time.

44. Screen number 29. Starts the review of evidence supporting Wegener's theory of continental drift with evidence of SHAPE. Suggest that it be placed on the dustless chalkboard and student's notebook.

45. Screen number 30. Continues with evidence of FOSSILS.

46. Screen number 31. Continues with evidence of ROCKS.

47. Screen number 32. Continues with evidence of ICE SHEETS.

48. Screen number 33. Starts "check up," a review, in the form of a multiple choice test. The answers is D, ice sheets.

49. Screen number 34. Verifies the correct answer.

50. Screen number 35. Shows Alfred Wegener's diagram of the supercontinent of Pangaea. The student is asked to identify, by moving a crosshair (by pressing the down arrow key) to the part of the supercontinent that will become the North American continent.

51. Screen number 36. Verifies the correct answer and then labels the diagram of the continent of Pangaea into its presently formed continents. Notice that the "ret" key is blinking, signaling the end of a sequence and offering the possibility of reviewing this sequence at this time.

52. Screen number 37. Presents the section menu. This is the logical end of this lesson, therefore you do not want the students to advance at this time. Suggest that students review the last sequence or start the completion of the hand-out sheets.

Summary:

List four examples of evidence and explain how they explain the Theory of Continental Drift.

Application:

How could satellites be used to gather additional evidence that the continents do drift?

Assignment:

1. Describe evidence that shows that the present-day continents may have once been one supercontinent.

III

The Atmosphere

TOPIC 8 - The Weather and the Atmosphere

Introduction:

The study of weather provides students with the opportunity to observe that the atmosphere is in a constant state of change. Because of our day-to-day concerns with weather conditions and our familiarity with weather forecasts, this topic is highly motivating and students are often eager to develop their own weather forecasts based upon the material learned in class. It must be emphasized that success in this topic requires that students master the weather fundamentals and develop skill in collecting data, observing local conditions and understanding how weather systems interact. Teachers should be sure that the students have an understanding of weather fundamentals and should resist the urge rush through the fundamentals quickly.

Aim: What is weather?

Performance Objectives: Students will be able to:

- understand that weather refers to short-term changes which occur in the atmosphere
- understand that unequal heating of the earth's surface causes pressure differences which put the air into motion
- understand that north and south of the equator the direction of moving air is altered by the earth's rotation
- understand that high and low pressure areas in the atmosphere play a major role in producing weather changes
- understand that in the continental United States (middle latitudes) highs and lows carry certain general weather characteristics with them as they migrate across the earth's surface.

Materials:

- Apple computer lab
- Crossword Magic software
- data disks containing previously prepared weather puzzles

* alternative: The crossword puzzles can be prepared on a single computer equipped with a dot matrix printer. A hard copy (printed on paper) of the puzzle can be prepared and reproduced for use in the classroom.

Motivation:

Use these "do now" questions to stimulate discussion about the weather and to make the students aware that the weather consists of many individual weather characteristics.

1. What weather characteristics can you see if you look out a window? (direct visual observation)

2. What weather characteristics can you observe indirectly?

3. What weather characteristics can you feel but not see?

Development:

Use the crossword puzzle prepared with the help of Crossword Magic to introduce the vocabulary and basic concepts which will prepare the students to start their study of weather.

Sample vocabulary list

weather
pressure
horizontal
rotation
low
precipitation
coriolis
isobar
latitude
wind
atmosphere
energy

Sample Clues: The clues should be presented to the students within crossword puzzle format provided by the software. Because many of the students may not be familiar with the vocabulary words, a list of the words should be provided on the chalkboard. The children will be forced to match the correct definition with each vocabulary word before being able to complete the puzzle.

a) The atmospheric conditions in a given place and time are ______________.
b) The horizontal movement of air from high to low pressure areas is called ______________.
c) Unequal heating of the atmophere causes areas of unequal ____________ to develop.
d) Winds blow from areas of high pressure to ____________ pressure areas.
e) North and South of the equator, wind direction is changed due to the earth's ______________.
f) The change in the direction of moving air is called the ____________ effect.
g) In the middle ________________ highs and lows carry weather characteristics with them.
h) Low pressure areas are often associated with _______________.
i) The sun supplies the ____________ that makes weather systems move.
j) Lines on a weather map used to connect areas of equal pressure are called ______________.

Summary:

1. What is weather?

2. Why must measurements be taken to determine how the atmosphere is changing?

3. What causes winds?

4. How does the rotation of the earth affect the horizontal movement of air?

5. What type of weather is generally associated with low pressure air?

6. What is the energy source that powers the weather machine?

Homework Assignment:

Have the students start to build their individual weather glossaries by assigning the following words. The students should define each word and use it in a sentence. As additional vocabulary words are encountered remind the students to add them to the glossary.

weather
pressure
wind
high (weather)
low (weather)
precipitation
atmosphere
meteorologist
isobar
isotherm
insolation
front (weather)
coriolis effect

*Be sure to review this homework assignment in class and assist students that encounter difficulty in defining these words.

TOPIC 9 - Air Masses

Aim: How do air masses influence our weather?

Performance Objectives: Students should be able to:

- recognize the characteristics associated with continental, maritime, tropical and polar air masses.
- use a map to demonstrate where each of these air masses originates.
- explain why air masses migrate from their original location.
- explain how air masses influence our weather.
- demonstrate why continental air masses are associated with high pressure and maritime air masses are associated with low air pressure.
- explain why air masses undergo gradual changes as they migrate from their origin.
- explain why tropical air masses have a greater impact on our weather in the summer and polar air masses have a greater impact on our weather in the winter.
- explain why air masses generally tend to move from west to east across the United States.

Materials:

Video tapes of selected weather forecasts that show the way that large masses of air move across the United States. A large map of the United States.

Do Now: What characteristics will be found in air in each of these locations?

1. A dry, hot desert area that receives many hours of sunlight daily.
2. A subtropical ocean that receives many hours of sunlight.
3. An inland area in the northern part of the Unites States.
4. A snow covered plain above the arctic circle.

Hint: Have the students describe the temperature and moisture content of the atmosphere in each of these locations.

Motivation:

Play the video tapes and emphasize the movements of air masses. If necessary rewind the tape and replay it after discussing how air masses move.

Development:

1. Review the "Do Now" questions and emphasize that air masses from continental regions contain less moisture than air masses from maritime regions. Also review the relationship between low pressure and wet weather.

2. Students should understand that air masses with a maritime origin contain low pressure and wet air.

3. Students should also understand that air masses with a continental origin contain high pressure and are associated with dry or fair weather.

Pivotal Questions:

1. How do air masses form?

2. Why are continental polar masses more likely to influence our weather in the winter than in the summer?

3. Why are maritime tropical air masses more likely to influence our weather in the summer than in the winter?

4. What happens to an air mass after it migrates from its source region? Why?

5. Why do air masses tend to move generally from west to east across the United States?

6. How can we identify or classify air masses?

7. Why can the weather conditions in the middle latitudes be described as a continuous war between different air masses?

Testing for Comprehension:

At appropriate points during the development of the lesson, call upon students to go to the map and have them show the class the origin of the appropriate air masses. For example, while discussing question #3, have a student point out a possible location where maritime tropical air masses may form. By the completion of the lesson students should be familiar with the major types of air masses that influence our weather.

Completion Activity:

Place the chart on the chalkboard and have the students insert the missing sources and characteristics.

Source	Characteristics
High latitude	------------
------------	warm
land	------------
------------	moist
Tropical Ocean	------------
------------	cold and dry

Summary:

A large very cold air mass called the Siberian Express in many TV weather reports moved from northern Canada to the central U.S. What effects could it have had upon the weather in the eastern part of the U.S.? What changes occurred in the air mass as it moved towards the Southeast?

Homework Assignment:

1. How do air masses develop?

2. Why do meteorologists often call the continental United States a battlefield for air masses?

3. Why do maritime tropical air masses have a greater impact upon our weather during the summer months?

4. Why do continental polar air masses have a greater impact upon our weather during the winter months?

5. What happens to an air mass after it moves away from its area of origin?

Extended Assignment:

Present the students with this assignment after checking to see that appropriate weather conditions exist.

For the next 5 days use a newspaper weather map to observe the movements and changes that occur as a major air mass moves across the United States.

1. Select an air mass that is still near its origin location. Use either a continental polar or maritime tropical air mass.

2. Follow the movement of this air mass daily by using the newspaper weather maps. Answer these questions daily.

   a. In which direction is it moving?
   b. What effect does it have on the weather as it moves?
   c. If the air mass reached New York City, how did you know that it arrived? What weather changes did you observe?

3. Paste your weather maps onto the papers with the answers and submit your air mass scrapbook at the completion of the assignment.

TOPIC 10 - Weather Changes

Aim: Why do weather changes occur?

Performance Objectives: Students will be able to:

- understand that the movement of air masses causes our weather to change.
- define a front as the leading edge of an air mass.
- understand that when a weather front passes, weather changes can often be observed.
- understand that warm and cold fronts each bring distinctive weather changes.
- understand that symbols or models can be used to depict the sky condition and other weather data.

Materials:

- IBM or compatible computer lab
- Prentice Hall Weather Forecasting Software (diskette #2)

Do Now:

What methods would you use to show local weather conditions on a map? What problems may result if every meteorologist used a different set of symbols?

Use this activity to make the students aware that people's lives often depend upon reading weather maps. Introduce the thunderstorm symbol and demonstrate the way that it may be used on a pilot's weather map. What may happen to an aircraft if the pilot was unaware of thunderstorms along the route.

Introduction to the Use of Computers:

Before distributing any diskettes or turning on the computers, advise the students of the proper method for handling diskettes. Warn the students NEVER to touch the exposed surface of the recording media, fold the diskette, or keep it outside the protective folder.

1. Before turning on the computers, have the students insert the diskettes into drive "A and close the door.

2. Turn on the computer power switch. It is located on the right side to the rear of the computer.

3. Turn on the monitor power switch.

4. This software is self loading and will start running automatically.

Development:

1. If the students loaded the correct software, the computer will provide a menu containing three options. Instruct the students to select option 1 - weather changes.

Note: The introductory section of this software package contains some graphics and questions which may appear simple or even childish to some junior high students. Advise the students that the software starts by teaching weather fundamentals and soon advances to more serious work. Be sure to warn students that they should pay attention to the weather symbols which are introduced with each screen.

2. Allow the students a reasonable amount of time to operate the program and answer the questions on the computer. The computer program will introduce the relationship between different weather conditions and weather map symbols. The software will also demonstrate air mass movements, the passage of fronts, and the locations in the atmosphere where cloud formation may occur. Following the instructional activity, the software will provide the students with an opportunity to answer questions and will also provide tutorial exercises for those questions which they answered incorrectly.

3. If some students finish the activity ahead of the class, suggest that they insert diskette #1 and learn the vocabulary by selecting the vocabulary activity from the menu.

4. At the completion of the computer guided instructional activity have the students remove the program diskettes and return them to the software folders. Warn the students that the protective sleeves must be covering all exposed parts of the recording media. The students should then turn off the computer switches and monitors.

Summary Questions:

1. What causes weather changes to occur?

2. What are three ways in which we can recognize the passage of a weather front?

3. Where do clouds usually form?

4. How would a cold front appear to look if we could see a cross-section view of the moving air?

5. How would a warm front appear to look if we could see a cross-section view of the moving air?

6. What is the difference between a warm front and a cold front?

7. Which type of air mass is associated with fast moving thunderstorms or showers?

8. What type of air mass is associated with all-day rainstorms?

Homework Assignment:

1. What is the major cause of changes in our weather?
2. How can we tell if a weather front passes through our neighborhood?
3. What are the different characteristics found in warm fronts and cold fronts?
4 What symbols are used to represent thundershowers, rain, clear skies and cloudy skies on a weather map?
5. What type of weather front is often associated with a fast moving thunderstorm?

TOPIC 11 - Weather Fronts

Aim: What are weather fronts?

Performance Objectives: Students will be able to:

- describe the reasons why the air in contiguous air masses does not readily mix.
- identify weather fronts as the boundaries or interfaces separating the air masses.
- explain why abrupt changes in the weather often occur across weather fronts.
- describe the weather changes associated with the passage of a front
- explain how weather fronts are drawn on a weather map.

Do Now:

Place the questions on the chalkboard and instruct the students to answer them in their notebooks.

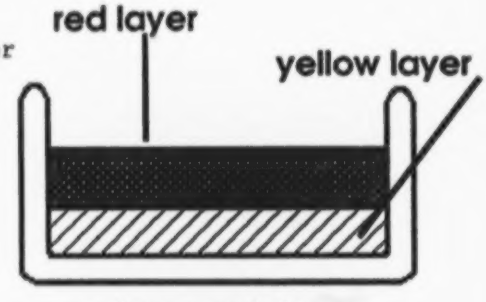
1. What happens when a continental polar air mass bumps into a maritime tropical air mass?

2. Why does it often rain when a warm air mass arrives?

3. How can we identify the boundary between different air masses?

Materials:

- One large beaker or other transparent container
- Two 150 ml. beakers.
- Hot and cold water
- Food coloring - red and yellow



a glass container or beaker

Computer Activities:

- IBM or compatible lab
- IBM Software - Moisture in the Atmosphere

Motivation:

Take 2 large beakers. Place 75 ml. of very hot water in one beaker and add red food coloring. Place 75 ml. of cold water in the second and add the yellow food coloring. Gently pour the cold water into the bottom of the large container and allow it to stop moving. Gently add the hot water to the same container, allowing it to slowly run down the side of the container without disturbing the cold water. If you have been successful you would end up with a distinct layer of hot water (red) floating above a distinct layer of cold water (yellow). As an alternative you can use a beaker containing a layer of oil floating on water to also demonstrate the interface between materials of differing densities.

It is suggested that you try the hot/cold water demonstration in the preparation room prior to demonstrating it to the class.

Development:

1. Why do the two parcels of water remain separate? Elicit from the students that the difference in temperature is the cause of the separation.

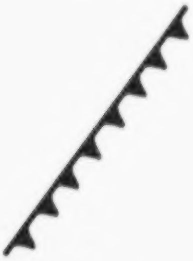
2. What would have happened if we put the hot water on the bottom and poured the cold water on top?

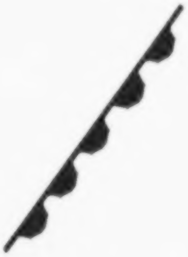
3. How does the energy of the molecules in the warm water differ from the energy of the molecules in the cold water?

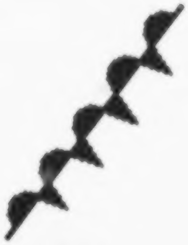
4. Describe the boundary between the two layers of water (or between the oil and water) as an interface and explain to the students that the two layers do not readily mix because of the density differences. Guide the students to develop an understanding that the molecules of cold water are less energetic and are packed closer together than the molecules of hot water.

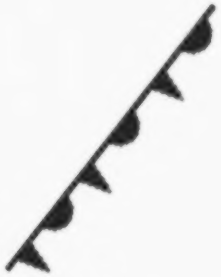
5. How does a weather front compare with the boundary between the two layers of water? Be sure that the students understand that air masses tend to remain distinct due to density differences between the air masses caused by a difference in temperature.

6. Introduce the boundary as a weather front. Explain that when a cold air mass replaces a warm air mass it is called a cold front and when warm air moves in to replace a cold air mass it is called a warm front. Introduce the concept of the weather front and challenge the students to develop a symbol for a stationary front. Explain the stationary front as a situation in which warm and cold air masses collide and remain stationary pushing against each other in opposite directions. Present students with the symbols used on synoptic weather maps.


symbol for cold front


symbol for warm front


symbol for stationary front


symbol for occluded front

7. What happens to the weather when the passage of a front occurs? Elicit from the students that there might be changes in air presure, temperature and cloud cover. Review the concept of the High and Low and remind the students that a cold front would indicate the arrival of a high pressure area while the arrival of a warm front will indicate the arrival of a low pressure area. Be sure that the students are aware that abrupt changes can occur in the weather variables as the passage of a front occurs.

8. What type of weather is associated with the passage of a cold front? Guide the students to understand that because the cold air is denser and heavier than the light air, it forms a wedge which pushes under a warm air mass and lifts it up. The barometer rises sharply and there may be thunderstorms which may be intense but last for a short duration. Guide the students to understand that the passage of a cold front may occur without any precipitation if the warm air is relatively dry and there is not enough moisture available to develop a line of showers. Be sure that the students are familiar with the cross-sectional diagrams of warm and cold fronts.

9. What type of weather is associated with the passage of a warm front? Guide the students to develop an understanding that warm fronts are often less distinct than cold fronts and are more difficult for meteorologists to identify. Warm fronts are preceded by thin high cirrus clouds and as the front approaches the clouds thicken and darken. The students should be made aware that the appearance of sucessively lower and darker cloud cover indicates the arrival of a warm front. Warm fronts are often associated with long periods of steady rain, a falling barometer, rising temperature and a change in wind direction.

Computer Activity: Use an IBM or compatible lab

1. If the students have not run the Prentice-Hall Earth Science Weather Station program, it contains a short segment that illustrates the way that fronts are portrayed on a weather map.

IBM Software - Moisture In the Atmosphere:

1. If you have not used this software before you must make a self-loading version of the disc for class use. To do this you must load the DOS and follow the instructions contained with the software. After you prepare the backup copy of the disc you can instruct the students to operate the program by inserting the disc into drive "A", closing the door, turning on the monitor and the computer.

2. When the menu appears, instruct the students to select option 2 - Clouds and Precipitation. Then the machine will provide the student with a submenu. Instruct the students to select section 6 - Frontal Uplift. This software will continue to run through the remaining sections-Clouds and Raindrops-without stopping.

3. In addition, some of the material in this software uses vocabulary which you may not have introduced to your class. Review this material. You may also choose to use this software with a future lesson or as a review of the entire unit.

Homework:

1. What prevents the air in contiguous air masses from mixing?
2. Why are weather changes often associated with the passage of a front?
3. Why do clouds often form along the boundary between air masses?
4. How does the passage of cold front differ from the passage of a warm front?

TOPIC 12 - Wave Cyclones

Aim: How do wave cyclones influence our weather?

Performance Objectives: Students will be able to:

- describe the conditions that are necessary for a wave cyclone to develop
- explain how wave cyclones move across the United States
- explain how meteorologists can often predict where a wave cyclone will develop
- describe the life cycle of a wave cyclone
- identify the features associated with a wave cyclone on a weather map
- describe the relationship between a wave cyclone and an occluded front

Materials:

Chart or other visual materials which show the formation of a wave cyclone. As an alternative you can prepare a rexographed handout showing the life cycle of a wave cyclone, a sequence of weather maps that show the development of a wave cyclone (class set), an overhead projector and a set of overhead projector transparencies can be used.

Do Now:

1. Describe the way that air circulates around a high pressure area. (anticyclone)

2. Describe the way that air circulates around a low pressure area. (cyclone)

3. What would you expect to happen if a low pressure area or warm air mass lies directly across the front from a high pressure area or cold air mass?

Motivation:

Draw the diagram on the board and challenge the students to describe what might happen if a section of the front was disturbed.

What might cause a disturbance along the front? Elicit from the students that the disturbance may result from topographic features such as mountains or even local wind conditions (convection currents). Describe the disturbance which occurs in the atmosphere as a ripple or wave and explain to the students that waves develop within the atmosphere in much the same way that waves occur on the surface of water when a rock is thrown into the water causing a disturbance.

Development:

Introduce the term wave cyclone and define it for the students. A wave cyclone or frontal wave is a disturbance which forms along a stationary front or a slow moving cold front. As a result of an atmospheric disturbance the warm air begins to flow up and over some of the cold air. The cold air behind the disturbance then flows in and replaces some of the warm air. One section of the front acts like a warm front and the other acts like a cold front.

1. What happens to the weather conditions when a wave cyclone develops? Elicit from the students that the warm and cold air masses collide or push up against each other.

2. How does a front develop into a storm? Challenge the students to describe the order of events that occur and then provide the students with the following sequence.

   a. The pressure at the peak of the frontal wave falls.
   b. A low pressure center forms and a cyclonic (counter clockwise) circulation develops as air rushes into the low pressure area.
   c. This system may develop into a major storm which will generally move from the west to the east. Rising air cools and precipitation results.
   d. As the wave cyclone moves across the United States it may or may not change latitude.
   e. The cold front part of the wave cyclone moves faster than the warm front segment and overtakes it.
   f. The pocket of warm air is then forced up. It is squeezed upward into the atmosphere as the cold air behind the cold front collides with the cold air preceding the warm front.
   g. When the warm air mass is lifted up into the atmosphere this front is called an occluded front and is represented on weather maps by this special symbol.
   h. This is the period of greatest storm intensity and the weather system contains widespread cloudiness and heavy precipitation.
   i. The storm system diminishes in intensity as the occlusion grows in length because the cyclonic circulation slows and the low pressure center begins to fill. The intensity of the storm also generally diminishes as the temperature differential between the warm and cold air masses is reduced.

3. Distribute a sequence of weather maps or use a series of maps on overhead projector transparencies to illustrate the sequence of events that occur throughout the formation of a wave cyclone.

4. Emphasize the way that the cold front behind the warm air mass overtakes the cold air ahead of the warm front.

5. Where does the warm air go when the fast moving cold front overtakes the preceding cold air mass?

6. Draw the sequence of cross-sectional diagrams on the chalkboard and walk around the room to insure that the students copy the diagrams correctly. Be sure that the students understand the relationship between the cross-sectional diagrams and the fronts drawn on the weather map.

Summary:

1. What type of conditions are necessary for a wave cyclone to develop?
2. Why does precipitation develop in the center of the wave cyclone?
3. How does an occluded front develop?
4. How do wave cyclones travel across the United States?
5. Why do wave cyclones finally dissipate?

Homework Assignment:

1. What is a wave cyclone?
2. How does a wave cyclone differ from a low pressure area?
3. Why do wave cyclones dissipate?
4. What is the role of mountains or other local conditions in the formation of a wave cyclone?
5. What conditions are necessary for the formation of a wave cyclone.

TOPIC 13 - Weather Variables

Aim: How do meteorologists observe and record the weather variables?

Peformance Objectives: The students will be able to:

- name and explain the significance of each of the weather variables
- explain how meteorologists measure each of the weather variables
- identify the equipment used to perform weather variable meausurements
- explain which units are generally used for each of the measurements
- explain how meteorologists use local measurements of the weather variables to develop forecasts for broad areas

Materials:

- A set of weather instruments: thermometers, psychrometer, wind vane, anemometer, barometer, rain guage.
- Photographs from weather satellites and pictures taken from radar or a video tape of a weather forecast demonstrating weather radar.
- Computerized weather station (if available).

Do Now: Place the following assignment of the chalkboard.

List 8 different factors that may be included in a complete weather report. Describe the instruments or methods of observation that a meteorologist may use to obtain information about each of these weather variables.

Development:

Review the student responses to the "Do Now" assignment. Be sure that the students have been introduced to each of the weather variables and the instruments which can be used to collect data.

temperature-thermometer
humidity-psychrometer
wind direction-wind vane
wind speed-anemometer
air pressure-barometer
solar radiation (sunlight)-observation
sky-cover - observation
precipitation-rain gauge

1. Demonstrate or display each of the instruments and elicit from the students which variables can be measured with each of the devices. Discuss the types of units with which the instruments may be calibrated. Introduce the students to both the metric and customary units as these are presently used for surface measurements by the National Weather Service.

   If the students experience difficulty learning the names of the weather instruments you can prepare a cloze reading exercise or a crossword puzzle utilizing an Apple and Computer and Crossword Magic.

2. Question: If you had all of this equipment available, how could you operate your own weather station? Elicit from the students that it would be necessary to take readings at regular intervals and record the data. Guide the students to develop an understanding that by observing changes in the data we can often obtain clues about coming weather conditions.

This will enable us to make predictions or forecasts based upon the clues we observe.

It is suggested that you set up a large chart for recording the weather variables daily. Have students take the readings daily and encourage them to try to identify patterns or trends in the data. These may provide clues about upcoming weather conditions. The measurement process can be assigned to a group of volunteers or performed on a rotating basis to permit as many students as possible to participate in this on-going activity.

3. How can we obtain readings when school is closed? Introduce the concept of recording instruments that collect and record data automatically. Display and demonstrate the recording barograph and thermograph. Both of these devices are found in most school labs.

4. How do meterologists obtain weather data from uninhabited locations? Discuss the need to monitor weather conditions in arctic regions, at sea, and from balloons in the upper atmosphere. Use these as examples of locations where weather information must be gathered automatically. Guide the students to develop an understanding that weather data from these locations can provide meteorologists with clues about developing trends which can influence the weather in inhabited regions.

5. Demonstrate an automated weather station program. If you have a safe location in which to leave a single computer operating continuously for several days you can actually use the automated weather station program to gather data for an extended period of time. There are several computerized weather station programs available. If you have a single VIC 20 or Commodore 64 you can use AUTOMATED WEATHER STATION by Vaisals Inc. This unit consists of a hardware sensor device which must be mounted outdoors, out of the direct sun, and is connected to the computer by a 15-foot cable. This program automatically records temperature, humidity, dewpoint, and atmospheric pressure. It also calculates the wind-chill factor, relative humidity, and cloud attitude. The program will collect and store data for up to 36 hours and also has the capability to graph data and output to the printer. The HRM Weather Station is part of the EXPERIMENTS IN SCIENCE software/hardware package for the Apple 2 series of computers. This program is designed to demonstrate how an automated weather station operates and is not designed for permanent installation outdoors. It does not come equipped with long leads and the probes are not weatherproofed. This program measures and records wind speed, air temperature, relative humidity, and insolation. This program requires extensive preparation before you use it in the classroom. It is necessary for the computer operator to take probes and tape them together to actually make the device which measures wind speed. In addition, the temperature probe requires calibration the first time that it is used with a specific computer. The relative humidity measurements require a wet bulb on one of the probes. This requires that you attach a wick to the end of the probe and place the end of the wick in a source of water if you plan to use it for taking a series of readings over an extended period of time. This will insure that the wet bulb remains moist.

Both of these programs can be operated by a group of students, who can be assigned to operate the station and monitor the data that is being collected. If you are using the HRM program it is possible to purchase an extra set of probes and mount them inside a suitable enclosure to create a permanent data collection station. The light sensor must be mounted in the sun and the temperature probes must be placed in a location where they are shaded from the sun and receive a sufficient flow of air to record the air temperature and wind speed accurately.

6. How can we issue school-wide weather reports?

   Once the students become proficient at operating the weather instruments, you can encourage the students to write a daily weather report for the school community. They can post the daily measurements on a large chart in a public area or perhaps have the information included in the announcements which are made over the school PA system. As the students start to recognize patterns in the data which is being recorded they can try to predict future weather conditions and include these forecasts with the information which they have recorded.

Summary:

The goals of this topic were to make the students aware of the methods which meteorologists use to gather data about the weather variables and to learn some of the techniques which are used to make observations about the physical world. Be sure that the students understand that actual weather data is recorded from many locations and the patterns which emerge from this data are then used to issue forecasts for large areas.

Homework:

1. How would our lives be different if there was no National Weather Service?
2. Why do many airlines and farmers pay private weather services to prepare specialized forcasts?
3. List the weather variable measurements discussed in a TV Weather report. What weather variables were not included in the report? Why?

Supplementary Computer Activities:

1. Preparing a weather forcast

Materials needed: IBM or compatible computer software - FORECAST! by CBS Software, weather data obtained from class measurements

Procedure:

A. Place DOS in drive "A". Turn on monitor and computer. When the "A" cursor appears type "BASICA" then press "enter" key. When "OK" prompt appears remove the DOS disc and place program disc in drive "A". Type "RUN CBS" and then press "enter." Title screen will appear and will then be followed by a menu.

B. This program allows students to make weather forcasts based upon data that has been collected through measurements with the weather instruments or with an automated weather station. The program does not teach the significance of an automated weather station. The program does not teach the significance of observed trends or numerical readings but contains an excellent booklet that provides detailed information on the weather variables and their significance.

C. To operate the FORECAST! program, the students select option 1 - Weather Forecaster - from the main menu and enter the barometric pressure, barometric tendency (rising, falling, steady), wind direction, wind speed, dry bulb reading, wet bulb reading and present weather conditions. The program will use this information to prepare a forcast. The program also contains a Weather Calculator which allows students to make conversions from one type of unit to another, for example, inches Hg to millibars. The program contains provisions to record data on a data disc as well as other options which can be used to calculate weather for travellers or to track hurricanes.

2. Introduction to the weather instruments. Program - Earth Science Weather Station by Prentice-Hall; Computer - IBM or compatible

A. Students that were not in class when you introduced the weather instruments can see the instruments and learn their uses by running this program. The program is contained on two discs and is self-loading. To use the program insert the first disc into drive "A", close the drive door, turn on the monitor and the computer.

B. The program is divided into three segments, Preview, Instruction, and Evaluation. Allow the students to start with the Preview which introduces vocabulary. At the conclusion of the instruction segment the students are given a series of questions on screen which allows them to identify their individual weaknesses. Allow approximately 15-20 minutes for the students to run this software.

TOPIC 14 - Atmospheric Pressure

Aim: How do meterologists determine the atmospheric pressure?

Performance Objectives: Students will be able to:

- explain how a mercury barometer works
- explain what units are used for barometric measurements
- identify aneroid and mercurial barometers
- explain why cold air is often associated with higher barometric pressure
- explain why moist air causes the barometric pressure to go down

Do Now:

Place the following question on the chalkboard. Allow the students to answer it based upon their current knowledge. Many students will associate a rising barometer with warm temperatures. Following the Do Now activity, elicit student responses and list some of them on the board. Use these responses as an introduction to the developmental phase of the lesson.

Question: What types of weather can we expect when the weather forecaster says that the barometer is rising?

Materials:

- IBM or Tandy 1000 computer lab
- software: Forecast!

Motivation:

Demonstrate the concept of convection using either the convection box or a convection tube filled with colored water.

This demonstration will allow the students to see that a warmer fluid (a gas or liquid) rises and a cooler fluid descends.

Development:

1. What causes the warm fluid to rise? Assist the students in developing an understanding that as it is heated the molecules of that substance gain energy. As the molecules become more energetic they increase in motion and become more widely separated. Since there are fewer molecules per unit of area, the warm fluid tends to rise because it is not lighter in weight than a corresponding sized mass of cool fluid (air).

2. How does a barometer actually measure the pressure of the atmosphere? Explain how a barometer functions and provide examples leading students to understand that the barometer actually serves as a scale finding the pressure or weight of a column of air pushing down on the instrument. You can display a mercurial barometer (if available) and show the students how the air pushed down forcing the mercury to rise up the tube.

3. Why would warm air temperatures cause the barometer to fall?

4. How does the pressure or weight of a parcel of moist air compare with the pressure or weight of a parcel of dry air? Guide students to develop an understanding that the pressure or weight of air varies with its composition. Moist air contains a greater quantity of water vapor than air which is dry. Challenge the students to name the elements which are found in water. Most of the students will probably be familiar with the expression H_2O but may not associate this formula with the gases hydrogen and oxygen. If they are familiar with the periodic table show them the location of hydrogen and elicit that hydrogen is the lightest element. Therefore when more hydrogen atoms are added to the atmosphere (by adding more water vapor) the air becomes lighter in weight and the air pressure (barometer reading) goes down. The students should understand that light hydrogen atoms displace nitrogen molecules which have a greater weight or mass.

5. What would happen to the barometric reading if a parcel of moist air replaced a parcel of dry air?

6. What units can be used to represent air pressure? If the students have been following the daily weather forecast and collecting data as part of a long-term investigation, they may have discovered that air pressure is usually given in inches Hg (inches of mercury). Refer back to the mercurial barometer and assist the students in developing an understanding of the origin of this unit. Introduce the millibar and teach the students that barometric readings are often recorded in millibars on weather maps.

Computer Activity:

Direct the student to load the software and select the WEATHER CALCULATOR from the menu. Distribute a weather map (rexographed sheet) which contains the isobars measured in inches Hg. Assign the students to convert the readings to millibars. This will allow the students to develop an understanding of the relationship between the two sets of units often used for barometric pressure and will also assist the students in developing an understanding of the method used to depict barometric pressure on a weather map.

Allow approximately 7 to 10 minutes for this activity.

Computer Activities For Independent Research:

Challenge the students to write a program that will convert inches Hg (barometric pressure) to millibars.

Homework:

Have the students write a short report on one or more of the following topics:

1. Torricelli and the development of the barometer.

2. How can the barometer be used to predict weather changes.

3. How does a barometer work.

TOPIC 15 - Temperature and Atmospheric Pressure

Aim: What is the relationship between temperature and atmospheric pressure?

Performance Objective: Students will be able to:

- explain why the air pressure drops when the temperature increases
- describe the relationship between air pressure and temperature
- explain why the measurement of temperature is actually a measurement of the kinetic energy of molecules in a substance
- describe the scales that are often used for the measurement of atmospheric temperature
- explain how temperature readings can be converted from Fahrenheit to Celsius and the reverse process

Materials:

Graph paper for student use, balloons, test tube and holder, bunsen burner or heat source, thermometers and recording thermograph if available, IBM computer lab, DOS diskette, Forecast! software by CBS.

Do Now:

1. Place on the blackboard a series of temperature and barometric readings that indicate the changes that have occurred on a typical day from 6 AM until 3 AM.

2. Distribute the graph paper and ask the students to plot a line graph showing the change in temperature and a second line graph showing the change in air pressure.

3. What relationship can you observe between temperature and atmospheric pressure?

Motivation:

Place a balloon over the neck of a large test tube and slowly heat the test tube. Note: this demonstration will give better results if you place a few drops of water in the bottom of the tube prior to heating. Be sure that the test tube that you are using is made of tempered glass (pyrex) and insist that any students participating in this demonstration wear safety goggles. The students will observe that as the test tube is heated, the balloon will start to inflate.

Remove the test tube from the source of heat and hold it under a stream of cold water. The students will now observe that the balloon collapses. Repeat the demonstration if necessary.

Questions:

1. Why did the balloon inflate when the test tube was heated?
2. Was any additional air allowed to enter the test tube during heating? Did the number of molecules of air inside the closed system increase?
3. What happened to the molecules of air when they were heated?
4. Why did the balloon collapse when the closed system was allowed to cool?

At the conclusion of the motivational activity the students should be aware that heated air expands and cooled air contracts. During this expansion and contraction the amount of air (number of molecules) remains constant. You can review the concept of molecular motion and the way that this motion increases with temperature. Elicit from the students that the measurement of temperature is actually a measurement of molecular motion or the kinetic energy of the molecules.

Development:

1. What should happen to the weight of the air in the test tube when it is heated. Elicit from the students that since the system remained closed and the number of molecules remained constant, the weight should remain constant. You can actually demonstrate this using a balloon and a triple beam balance if time permits.

2. What is the effect of warming the atmosphere on the barometric reading? Refer back to the results of the "Do Now" assignment.

3. Why does the barometer drop as the temperature is increased? Review the concept that the barometer acts like a scale which measures the weight of the air. Review the concept that when air pressure is higher the air is heavier and the barometer rises. In like manner when air becomes lighter the barometer falls.

4. When the morning sun causes the air to warm up, what happens to the number of molecules in a square meter of air?

   The students should now understand that as air is heated, it expands. Due to increased molecular activity each molecule occupies a greater amount of space. Therefore there are fewer molecules of air per cubic meter of space.

5. How do we determine the temperature of air? Elicit from the students that the instrument used is the thermometer and the units used to express temperature are degrees Celcius or Fahrenheit. Draw two thermometers on the board, label one Fahrenheit and the other Celcius. Indicate the freezing and boiling points of water and body temperature. Also provide the students with the conversion formulae. Explain to the class that most of the world uses the Celcius scale and in the United States we use Celcius for scientific measurements and customarily use Fahrenheit for measuring air temperature. Emphasize the fact that the National Weather Service uses Fahrenheit on ground level weather maps and Celcius readings for upper air measurements.

6. How do thermometers work? Elicit from the class that the liquid inside the bulb expands when heated and contracts when cooled. Relate this to the demonstration.

7. Where should we place a thermometer if we want to measure the temperature outdoors? What would be wrong with placing the thermometer in the sun? Guide the students to develop an understanding that heat energy from the sun will heat the liquid in the thermometer directly by radiational heating. This will not give us an accurate measurement of the temperature of the air surrounding the thermometer.

8. Where does the National Weather Service place their thermometers? Elicit from the students that thermometers are shaded from the sun and are placed in locations where they are exposed to moving air. In New York City some measurements are taken in Central Park. Discuss the use of a properly ventilated box which protects the thermometers from solar radiation and precipitation.

Measurement Activity:

If you have not set up a method for recording changes in the weather variables you should do so now. You can use a thermograph and recording barograph or recording weather station to make a class record of changes in the weather variables. If you have been operating a class weather station and have collected data, place the data on the chalk board and review the relationship between atmospheric pressure and temperature.

Computer Activity:

Hardware: IBM or compatible computer lab
Software: Forecast! by CBS Software
As this program has been used previously, follow the instructions in the previous lesson to load the program. This program requires the use of the DOS disc.

When the menu appears on screen instruct the students to select option 2, the Weather Calculator. This program converts temperatures and other weather variables from one measurement scale to another. To help the students become familiar with the relationship between the Fahrenheit and Celcius temperature scales place the temperature readings you have collected with your weather station on the board and have the students make the conversations.

Distribute a rexographed weather map containing isotherms marked in degrees Fahrenheit. If you do not have maps available, you can prepare a stencil using a newspaper weather map as a guide. Assign the students the task of converting temperature readings from one scale to the other? Relate this skill to aircraft pilots who use both ground level and upper atmosphere weather maps in planning routes.

Independent Activity for the Programmer:

Write a short program that will use the conversion formulae to change Fahrenheit to Celcius and the reverse.

Summary:

1. Why does the barometer often fall during the morning hours?

2. How can we distinguish between the barometric changes caused by changing temperatures and those caused by the moving of air masses?

3. What procedures should we follow if we want to get an accurate measurement of the atmospheric temperature?

Homework:

Vocabulary: Define each of these words and use it in a sentence.

kinetic energy
Fahrenheit
Celcius
molecule

Questions:

1. Why does air expand when it is heated?

2. What happens to the atmospheric pressure as the temperature increases? decreases? Why?

3. If you want to keep a careful record of the temperature outside of your house, how should you mount the thermometer?

Research:

Write a short report on the invention of the thermometer, or a short biography of either Gabriel Fahrenheit or Andre Celcius.

TOPIC 16 - Weather Maps

Aim: How can weather conditions be represented on a map?

Peformance Objectives: Student will be able to:

- recognize the symbols for warm, cold, and occluded fronts
- identify high and low pressure areas on a weather map
- draw isobars on a weather map and recognize areas of equal barometric pressure
- draw isotherms on a weather map and identify areas of equal atmospheric temperature
- identify areas of precipitation on a weather map

Materials:

- IBM computer lab
- software: Earth Science Weather Forecasting by Prentice-Hall
- thermograph and barograph strip charts or data recoreded from weather reports showing the passage or warm and cold fronts.

Motivation: Place the following on the chalkboard:

Monday 9:00 AM	Tuesday 9:00 AM
temperature 18 degrees C	temperature - 23 degrees C
sky condition - clear	sky condition - heavy clouds with rain
air pressure - 1025 mb	air pressure - 998 mb

Questions:

What caused these changes to occur? How can these changes be shown using cross-section drawings of the atmosphere?

In reviewing the student responses, elicit from them that the weather changes occurred due to the passage of a warm front. Review the characteristics of air masses and be sure that the students understand the relationship between air pressure and temperature.

Development:

1. Display the thermograph and barograph and the recorded data or charts. Place the data on the board so that all of the students can observe data that was actually obtained during the passage of a front.

   Challenge the students to develop a system for representing weather conditions on a map.

2. Review students responses and tell them that the program they are about to use will teach them the major features which are drawn on a weather map and will also allow them to interact with the computer in order to draw lines representing air pressure and temperature on a weather map.

3. Remind the students of the correct method for handling discs and tell them to insert disc 2 into drive "A". The students should turn on the monitors and computer power. The program is self-loading.

4. When the menu appears on the screen, instruct the students to select option 2 - Weather Maps. A second menu will appear on the screen which allows the students to review the "science skill-reading weather maps". This will review the material which was introduced previously in class and during the motivation exercise. Following this brief review the students will be directed to the main instructional menu.

5. The computer-directed instruction starts with a series of weather maps containing moving graphics which show students how high and low pressure areas are represented on a weather map. The students are then introduced to the concept of the isobar (using millibars). The students have the opportunity to work interactively with the computer to identify areas of equal barometric pressure and then place isobars on a weather map. The instructions for operating the software appear on the screen and allow each group of students to work at their own pace.

6. Following the isobar activity, there are similar modules for drawing isotherms and for drawing and reading other features of a weather map.

7. Allow the students a reasonable amount of time to complete the computer-directed activity and self-contained review. Suggested time 10-15 minutes. Instruct the students to remove the discs from the machines, turn off the computer, monitor and power switches and remind the students to put the diskettes into the protective covers carefully without touching the recording surface.

Summary Questions:

1. How are warm fronts drawn on a weather map?

2. How are cold fronts shown on a weather map? Have a student draw the cold front symbol on the board.

3. How do occluded fronts form?

4. How are occluded fronts represented on a weather map? Have a student draw the symbol on the board.

5. How are barometric readings shown on a weather map?

6. How do we show areas of equal barometric pressure on a weather map?

7. How are temperatures represented on a weather map?

8. How can we show areas of equal temperature?

9. How was precipitation shown on a weather map?

10. What symbol is used to show a low pressure area? A high pressure area?

Homework:

Prepare a rexographed weather map containing high and low pressure ares and a series of barometric readings.

1. Draw isobars connecting areas of equal barometric pressure.
2. What happens to the air pressure as you go outward, away from the center of a low pressue area?
3. What happens to the air pressure as you go outward, away from the center of a high pressure area?
4. Use the symbol "H" to identify the high pressure area and "L" to identify the low pressure area.

TOPIC 17 - Layers of the Atmosphere

Aim: How can we identify the layers within the atmosphere?

Performance Objective: Students will be able to:

- identify the layers of the atmosphere
- understand the meaning of interfaces of atmospheric boundary layers
- describe the varying conditions of each of the layers

Materials:

- graph paper
- table of upper atmosphere temperatures and altitudes
- colored pencils, markers, or crayons

Preparation:

Prior to teaching this lesson it will be necessary to prepare a table containing the appropriate data. The material can be placed on a rexograph stencil or a table can be drawn on the chalkboard.

temperature degrees Celsius	Altitude (miles)
+16	sea level (0)
0	2
-16	4
-40	7 1/2
-54	8 1/2 tropopause
-54	10
-54	13
-45	20
-38	22
-25	25
-18	27
0	30 stratopause
0	33
-29	40
-65	46
-90	50 mesopause
-90	53
-90	57
-73	65
-40	67

(note-this material has been obtained from the NYS Earth Science Reference tables-if you choose to convert miles into kilometers consult the reference table.

Do Now:

1. Distribute the graphing materials and instruct the students to plot a line graph. Advise the students that after they complete the graph they should draw three lines across the graph indicating the position of the stratopause, tropopause and mesopause.

2. The students should use three different colors, if possible, to draw the three lines. As an alternative to the graphing activity the students can use a computer graphing program to draw the graphs on the video screen. After the students have completed the graphs pose the question: why is the atmosphere divided into layers at the altitudes indicated on the table?

Development:

1. If the students have prepared the graphs correctly they should recognize that major shifts in the temperature patterns occur at these altitudes. Introduce the term interface and define it as a boundary between layers with different properties.

2. Challenge the students to identify interfaces that exist in nature. As an example - the boundary between the water at the surface of a lake and the atmosphere is an interface. Another interface exists between the water at the bottom of the lake and the soil or mud that is found on the lake bottom.

3. What do we find between the interfaces in the atmosphere? Challenge the students to use the graph to try to determine the conditions found within each of the layers of the atmosphere.

4. Introduce the terms troposphere, stratosphere and mesosphere and define each as a layer of the atmosphere. Draw a diagram on the board and show the students the location of each layer.

5. Why do pilots use oxygen when they fly at high altitudes? Elicit from the students that as you climb higher into the atmosphere the amount of air decreases. Guide the students into developing an understanding that gravity pulls down upon the atmosphere and holds the air around the earth.

6. Why is most of the earth's air located in the troposphere? The students should now understand that the force of gravity pulling downward upon the gaseous atmosphere holds most of the air close to the earth's surface. Also instruct the students that storms and clouds are located within the troposphere.

7. What type of conditions do we find when we fly up into the stratosphere? To assist students in answering the question inform them that most commercial airliners fly in the lower regions of the stratosphere. As many students have probably flown in a plane they should be aware that aircraft rise above the clouds and fly in clear air. Use the graph to provide information about the air temperature.

8. How do you know when you have crossed over from the troposphere to the stratosphere? Use this question to develop the idea that there are no sharp boundaries between the layers but simply changes in air temperature, air pressure and the composition of the atmosphere. Guide students to understand that temperature readings are used to identify the location of the interfaces between atmospheric layers.

9. How do conditions in the mesosphere differ from the stratosphere? Suggest that students refer back to their graphs and obtain information about the temperature changes. What happens as you climb through the mesosphere?

10. Where does outer space begin? Why does your graph fail to show an upper limit to the altitude of the atmosphere?

11. Guide the students to develop an understanding that as you rise through the mesosphere the number of air molecules decreases until you approach a region where there are only a few molecules of atmospheric gases per cubic meter of space. The students should understand that there is no sharp line separating the top of the atmosphere from the beginning of space.

Summary:

What criteria are used to divide the atmosphere into layers? Why is most of the world's air found in the troposphere?

Homework:

1. Vocabulary exercise - define each of these words: troposphere, tropopause, stratosphere, stratopause, mesosphere, mesopause.

TOPIC 18 - The Water Cycle

Aim: How does the water cycle affect our weather?

Performance Objective: Students will be able to:

- understand the recycling process of evaporation and precipitation
- understand the role of the water cycle in creating the components of atomspheric conditions

Materials:

Computer lab: Apple, Commodore 64, or TRS-80 software package- "Water and Weather" by Focus Media Inc. This software package consists of 3 programs: the Water Cycle, Clouds and Precipitation, and Humidity. As this package is available for the various microcomputers listed above, be sure that you have the appropriate software before inserting the diskette into the disc drive.

Motivation:

How old is the water that you used this morning to brush your teeth? (Discussion): Most students will insist that the water they used was new. They will claim that it just came out of the faucet. Challenge them with questions such as: Where was the water before it entered the pipes? or, how did the water get into the reservoir?

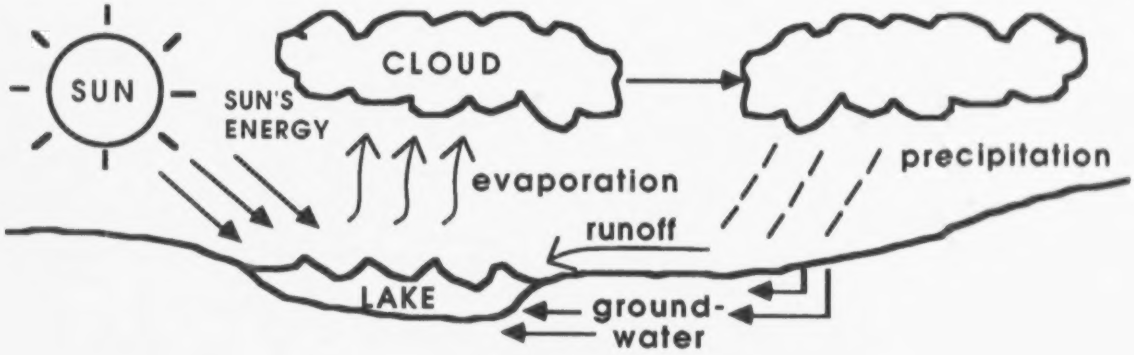
Guide the students to develop an understanding that our drinking water originally fell as rain.

Development:

1. Based upon the discussion of water, develop the concept of a cycle and demonstrate to the students how water is constantly recycled naturally by the processes of precipitation and evaporation.

2. A diagram placed on the chalkboard at this time will assist the students in understanding the concept of a water cycle.

Sample diagram:



3. Computer activity: After the students have developed a rudimentary comprehension of the water cycle, instruct them to load the programs and proceed.

    a. Insert diskettes into the drives, turn on the monitors and computers. The software is self-booting.

    b. The software package contains 3 programs and the students are presented with the opportunity to select the appropriate program. Instruct the students to select the program "The Water Cycle."

    c. Allow approximately 15-20 minutes for the students to operate the software. The software presents the material in the form of an instructional game. At the completion of the program, present the students with the questions provided below.

Review and Reinforcement:

1. How does water enter the atmosphere?
2. What is the role of trees and other green plants in returning water vapor to the atmosphere?
3. How does transpiration differ from evaporation?
4. How can we recognize saturated air?
5. What is the relative humidity of saturated air?
6. How can saturated air be made to hold more water?
7. What is condensation?
8. What conditions are necessary for condensation to occur?
9. What is the role of dust particles (condensation nucleii) in the process of condensation?
10. What is the energy source that powers the water cycle?

Summary: Questions for discussion

1. What happens to the water that goes down the drain?
2. Will the water that you flush down the toilet ever return to the reservoirs?

Homework: Vocabulary exercise

Define each of the words listed below and use each word in a sentence:

recycle
evaporation
transpiration
water vapor
saturated
condensation
sublimation
dew
frost
condensation nucleii

TOPIC 19 - The Formation of Clouds

Aim: How does water enter and leave the atmosphere?

Performance Objectives: Students will be able to:

- identify each of the forms of precipitation and explain the formation of each
- describe the operation of the water cycle
- describe how clouds form
- recognize the various types of clouds and describe the type of weather associated with each
- determine the dew point temperature and explain the significance of this measurement
- describe the significance of relative humidity

Materials:

- For "cloud in a bottle" motivation: rubber tubing, meter stick, flask, two-hole stopper, two pieces of glass thistle tubing, water, clamp, flashlight,
- For lesson: Alcohol swab or alcohol and paper towel
- photographs or slides of cumulous, stratus and cirrus clouds
- slide projector if necessary.
- IBM computer lab.
- Moisture in the Atmosphere - by IBM software Note: a self-booting backup copy for each computer station must be prepared prior to the lesson.

Do Now:

1. In what forms can water be found in the atmosphere?

2. Name four types of precipitation that fall from clouds.

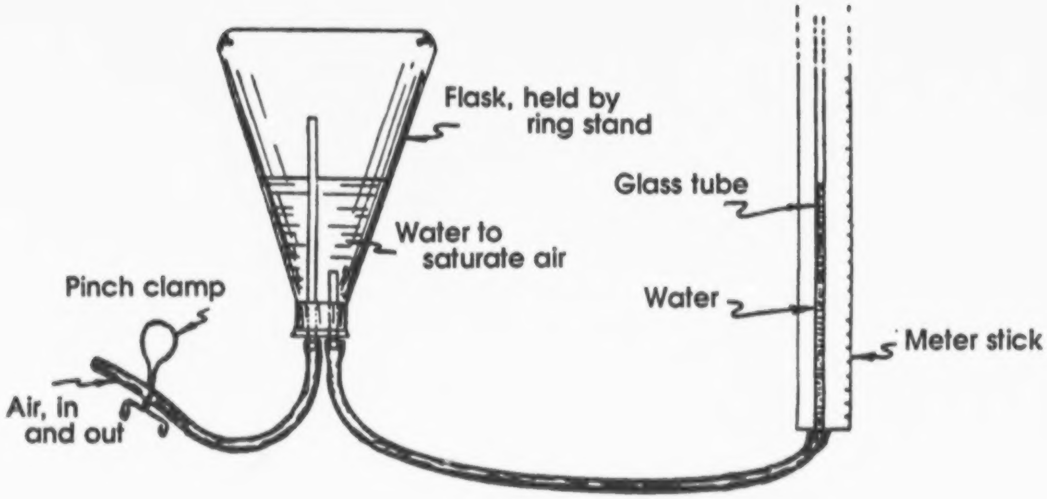
3. What conditions are necessary for each form of precipitation to develop?

Motivation:

Demonstrate a "cloud in a bottle" type of cloud chamber. First perform the demonstration without adding any smoke. No cloud will form in the flask. Repeat the demonstration after striking a match and allowing the smoke to enter the flask. Once smoke is introduced a cloud will form when the pressure in the flask is reduced. The cloud will be most visible if you darken the classroom and shine a flashlight through the flask.

See the diagram for help in preparing this demonstration.

The formation of clouds requires saturated moist air and a condensation surface. Saturation is achieved when the air is cooled adabiatically by decreasing the pressure and allowing it to expand (adabiatic process). Condensation surfaces, or nucleii, are usually particles of dust, smoke, salt, pollen etc. This demonstration can be used to show that a cloud results only when both condensation nucleii and reduced pressure are present.



Procedure:

1. Set up the apparatus as shown in the diagram. Force air into the flask until the water in the glass tube is to the top of the meter stick. Close the pinch clamp.
2. Open the pinch clamp suddenly. Observe the pressure drop as shown by the decreasing water level in the glass tube. Observe the air in the flask (no cloud should form)
3. Open the flask and allow some smoke from a candle to enter. Close the flask, return it to its original position and force the water level in the tube to the top of the meter stick. Close the pinch clamp.
4. Open the pinch clamp suddenly. Observe the pressure and the air in the flask (pressure falls, a cloud forms).

Precautions:

1. Swirl the water in the flask before carrying out the demonstration. This is necessary to saturate the air with water vapor.
2. A black card behind the flask will make the cloud more visible.

Development:

1. Review the "Do Now" assignment and guide the students to understand that all forms of precipitation result from the inability of the atmosphere to continue to hold water which has previously been contained within the atmosphere in the form of water vapor.
2. How does water vapor enter the atmosphere? Introduce the concept of evaporation and wipe the alcohol swab across the chalkboard. Challenge the students to explain what happened to the alcohol.
3. What is the role of the sun in adding moisture to the atmosphere?

4. What conditions are necessary for clouds to condense out of atmospheric water vapor.

   a. Refer back to the demonstration and elicit from the students that clouds form when water vapor is present in the atmosphere, particles are present upon which the drops will condense, and the air pressure is reduced. (These conditions were observed within the cloud chamber). Guide the students to understand that when air containing water vapor ascends, the temperature of the air drops and the atmospheric pressure is reduced. Under these conditions the air can not hold as much water in the gaseous form as previously and some of it condenses into droplets. These form the clouds that we see.

5. What are the major types of clouds that we see in the sky?

   a. Ask the students to describe the appearance of clouds that are often seen on a nice day? Elicit that they are large puffy white clouds that appear to tower high up in the atmosphere. Guide the students to understand that these clouds result from warm air rising upward into the atmosphere through convection. The cooling of this air causes condensation and cloud formation to occur. Introduce the term cumulous. Guide the students to understand that these clouds can develop into thunderstorm or cumulonimbus clouds. What factors determine the rate at which cumulous clouds form?

   b. How does the sky look when we have a full day of rain? Elicit from the students that the entire sky is covered with horizontal layers of clouds. Introduce the term stratus clouds. Guide the students to understand that stratus clouds are often associated with the arrival of a warm front or a low-pressure air mass.

   c. How can the sky tell us what type of weather is coming? Introduce the term cirrus clouds and describe them as thin, whispy clouds that reach across the sky and look like horse tails. Tell the students thay they are high altitude clouds and are composed of ice crystals. They are often a clue that a warm front (warm, rainy weather) is coming.

6. Have you ever walked through a cloud? Guide the students to understand that a fog is simply a cloud that is touching the ground. Fog forms when the atmosphere is saturated.

7. What factors determine the quantity of water vapor that can be contained within the atmosphere?

   a. Guide the students to understand that air temperature and the quantity of moisture in the atmosphere are the two key factors. When do clothes hanging outdoors dry the fastest? Elicit that dry days are best for drying clothes.

   b. Refer back to the alcohol swab on the chalkboard and ask the students to explain where does the water go when clothes dry?

    c. Would the clothes dry on a damp, foggy day? Introduce the concept of saturation and have the students develop an understanding that at a given air temperature the atmosphere can hold a specific amount of water vapor. Once the air becomes saturated, no additional evaporation will occur. The students should see the relationship between the amount of water vapor in the atmosphere and the rate of evaporation.

8. How can we determine the amouunt of water vapor in the air?

    a. Refer back to the demonstration and guide the students to develop an understanding that the temperature at which condensation occurs is dependent upon both the atmospheric temperature and the quantity of water vapor which the atmosphere contains.

    b. Introduce the term "dew point" and define it as the temperature to which a given parcel of air must be cooled so that it will become saturated and condensation will occur.

    c. Guide the students to develop an understanding that clouds form when the atmospheric temperature is equal to the dew point. Review the concept of adabiatic cooling and assist the students in developing an understanding that the altitude at the base of clouds is the point where the dew point is equal to the temperature.

Computer Activity:

Hardware: IBM computer lab
IBM Software - Moisture in the Atmosphere

Prior to the first use of this software it is necessary to make the discs into self-loading programs. Follow the instructions provided with the software for making a self-loading backup copy for use by the students. NOTE: This program will not self-boot on the Tandy 1000 machines. Instruct the students to insert the backup copy of the disc into drive "A", close the drive door, turn on the monitor and the computer, if the disc has been properly prepared it should start running and a menu will appear. Instruct the students to select part 2 - How Clouds Form.

This software will review the concepts introduced on cloud and precipitation formation. This software is quite technical and uses some vocabulary which may not have been introduced in class. It uses terminology such as orogenic uplift and the release of latent heat. It also contains several screens that allow the students to perform calculations. It is suggested that you preview it to determine if it is appropriate for your class. Instruct the students that they can skip individual questions by striking the "Enter" key without typing an answer.

Clouds and Precipitation - Program contents

1. The beginning
2. Adabiatic processes.
3. Dust in the atmosphere
4. Orographic uplift
5. Convectional currents

6. Frontal uplift
7. Clouds
8. Raindrops

At the conclusion of the instructional software there are two segements containing questions which can be used to determine if the students have mastered this topic. In addition, there is also a supplemental set of questions contained in the documentation which accompanies the software.

Homework:

1. What are the major types of clouds?

2. What conditions are necessary for the formation of clouds?

3. How does water enter the atmosphere?

4. Why does water leave the atmosphere?

5. What is the relationship between the dew point and the formation of clouds?

TOPIC 20 - Rate of Evaporation

Aim: What factors determine the rate of evaporation?

Performance Objectives: Students will be able to:

. test the relative humidity of a given location
. understand the effects of temperature and relative humidity in determining the rate of evaporation

Materials:

Apple computer lab, HRM Experiments in Science software/hardware package, wick material, small (50 ml) beakers, ring stand.

Note: Prior to this lesson the temperature probes must be calibrated and the calibration data must be stored on the program disc. All probes and all computers are different. If the computer or the probe being used is switched, the calibration process must be repeated. For additional information on the calibration process check p. 11 of the software documentation prior to preparing for this lesson.

Motivation:

Wipe an alcohol swab across the board.

1. Where did the liquid go?
2. How did the evaporation of the liquid affect the surface of the board?
3. Wipe some of the alcohol on the arm of a student volunteer. Ask the student to describe what is felt.
4. How would this demonstration change if we used water instead of alcohol?

Development:

Introduce the HRM interfacing equipment and demonstrate to the students that this interfacing device allows the computer to make measurements directly. Introduce the temperature probes and tell the students that they are being used instead of thermometers. What are the advantages/disadvantages of using a computer to gather information?

For the computer whiz. If the students are curious about the functioning of the temperature probe you can describe it as a thermistor - a resistor that varies with temperature. In other words it is an electronic device that allows more current to pass through when the temperature of the probe decreases. The computer reads the voltage and converts it into a temperature.

1. Starting the experiments. At the start of the activity instruct the students to place both probes into the styrofoam cup half filled with water at room temperature. This is required because both probes must be at the same starting temperature. Warn the students to check that the red probe is plugged into socket number 2. At this point select the appropriate software segment off the main menu. "Evaporation" segment number 11. Advise the students to enter 5 minutes for the experiment time length.

a. When the computer begins recording temperatures, the students will see a graph of the temperature and humidity appear on the display. Advise the students to ignore the humidity readings and to experiment with the temperature probes.

b. Suggest that the students dry both probes, warm one by holding it in the hand, cool one probe by fanning it. Have the students observe the changes that occur and then hold both probes in the air to see if they return to the same reading.

2. Evaporation: Instruct the students to take the black probes and dip them in water. Then hold the wet probes in the air. What happens to the temperature?

   a. Guide the students to take the probe, repeat the procedure but this time fan the drying probe with a piece of paper or shake the probe in the air. How did the cooling rates compare? Why?

   b. Instruct the students to attach a wick to the black probe and repeat the measurements. How did these cooling rates compare with the previous trials? Why?

3. Determining the relative humidity.

   a. Make sure that the wick on the black probe is moist.

   b. Hold the red probe near the black probe but keep it dry.

   c. Shake the probes gently in air.

   d. The computer will now determine the relative humidity and report it on the screen.

4. What happens to the relative humidity in a closed container?

   Procedure:

   a. Place about 1/2 inch of room temperature water in the cup.

   b. Place the probes so that they are inside the cup but above the level of the waer. Instruct the students to use masking tape to hold the probes above the level of the water.

   c. Guide the students to cut the cup lids so that they will fit around the probes and have the students cover the cups.

   d. Instruct the students to start a new graph and take readings for 5 minutes. What happens to the humidity within the cup?

5. If time permits you can perform an experiment to determine the relative humidity of very dry air. Place a dessicant in the bottom of a flask that has been warmed previously to drive off any moisture that may have remained inside. Moisten the black probe wick and insert both probes into a two-hole stopper. Start a new graph on the monitor screen.

Allow the students to compare the rate of evaporation with the evaporation rate in the previous experiment.

6. How can we determine the relative humidity without the use of a computer?

    a. Elicit from the students that we need two thermometers and instruct the students that one thermometer must be equipped with a wick or wet bulb. Display the psychrometer and demonstrate its use.

    b. How can a meteorologist convert the wet/dry temperature readings into the relative humidity? Introduce the relative humidity chart and instruct the students in its use. Instruct the students to look up the dry bulb temperature on the left side (vertical scale) and then calculate the wet bulb depression by subtracting the wet bulb reading from the dry bulb temperature.

    c. The number which is located where the two columns intersect is the relative humidity. Allow the students to practice determining the relative humidity from readings placed on the chalkboard.

7. How did the relative humidity measurement taken with the computer compare with the measurement made with the psychrometer? What factors may contribute to different readings?

Summary:

1. Why are meteorologists concerned with dew point and relative humidity measurements?

2. What happens to the atmosphere when the air temperature is the same as the dew point?

Homework:

Use a relative humidity chart to determine the relative humidity.

wet bulb	dry bulb
12	16
23	23
35	17

Note: all measurements are in degrees Celcius.

TOPIC 21 - Clouds and Precipitation

Aim: How do clouds and precipitation develop in the atmosphere?

Performance Objectives: Students will be able to:

- determine the conditions necessary for clouds to occur
- recognize the features of cumulous and stratus clouds
- understand the relationship between temperature and water saturation in cloud formation

Materials:

- Distillation apparatus and bunsen burner or other heat source
- Computer materials: computer Lab: IBM, Apple, or TRS-80
- Software package: "Water and Weather"

Motivation Question:

Why does the bathroom mirror become fogged when you take a hot shower? Challenge the students to explain why the mirror becomes fogged and list all of the possible answers on the board. Instruct the students to watch the operation of the distillation demonstration and see how it corresponds with the formation of droplets on the mirror.

Development:

1. Heat water within the distillation apparatus and advise students that the heat being applied to the flask is making the water within the flask change from the liquid to the gaseous state.

2. What form of energy in the enviroment causes water to evaporate? What happens to the gaseous water (water vapor) as it travels through the tube away from the heat source?

3. Demonstrate the cooling tube of the distillation apparatus and demonstrate how the rate of condensation increases when the water vapor is cooled more rapidly.

4. Return to the motivation question and the student responses. Elicit from the students that the water vapor condenses on the mirror because it is a cool surface and it is in contact with the staturated air.

5. Why does condensation occur within the atmosphere? What happens to the temperature of the air as you go higher up into the atmosphere?

   a. Elicit from the students that the temperature drops as you go upward into the atmosphere. If the students have difficulty comprehending this relationship it is useful to show a photograph of snow-covered mountains rising above a green forest.

   b. Introduce this decrease in temperature as the adabiatic lapse rate and remind students that if the temperature of moist air is decreased, so is its ability to hold water vapour.

c. Have you ever walked into a cloud? If the students are not familiar with the composition of clouds introduce the term fog and inform them that a fog is simply a cloud that reaches down to the ground.

d. What conditions would be necessary for the formation of a cloud? Elicit from the students that you would need saturated air and decreasing temperatures. In addition, remind the students that you would need a surface upon which the water droplets can condense. Tell the students that dust particles suspended in the air (condensation nucleii) provided the surface upon which condensation occurs.

Computer Activity: This software package is available for IBM, Apple and TRS-80 computer systems. Be sure that you have the correct software for your computers before starting the activity.

Software package: "Water and Weather"

1. Instruct the students to insert the diskettes into the drives, and then turn on the monitors and computers. Instruct the students to select the program "Clouds and Precipitation."

2. This program takes the form of a game and should be used after the students have learned the mechanics of the water cycle. The students should be familiar with the concepts of evaporation and condensation.

3. Allow about 10-15 minutes for the students to operate the software and become familiar with cloud formation, clouds and cloud types and the formation of precipitation.

Summary:

1. At the completion of the computer activity instruct the students to remove the diskettes from the drives and insert them back into the protective sleeves without touching the recording surfaces. Then have the students shut off the computers and monitors.

   a. What conditions are necessary for the formation of clouds to occur?

   b. Why do cumulous clouds look tall and fluffy while stratus clouds appear to form a flat layer across the sky?

   c. What conditions are necessary for precipitation to develop?

Homework: List the questions on the chalkboard.

1. In what ways does a fog differ from a cloud?

2. What type of air movement is associated with the formation of cumulous clouds?

3. Why should aircraft pilots be concerned about cumulous clouds when flying?

4. How can we recognize stratus clouds?

5. When does dew or frost form on plants?

6. How does condensation differ from sublimation?

7. What conditions determine the form of precipitation which develops?

8. What are the four types of precipitation?

IV

The Earth in Space

TOPIC 22 - The Size and Shape of Earth

Aim: What is the size and shape of the Earth?

Performance Objectives: Students will be able to:

- describe two observed phenomena that indicate that the Earth is round
- explain how the angle of the Sun changes given a direction relative to the Equator
- state the approximate diameter and circumference of Earth in kilometers

Materials:

Globe, two sticks, two pieces of cardboard, lump of clay, flashlight, transparency projector, photograph of Earth taken from space, transparencies of Figures 1, 2 and 3.

Motivation:

Put the following on the board:

Eratosthenes-- An Ancient Greek mathematician.

Tell the class that over two thousand years ago, Eratosthenes measured the size of the Earth, using just two sticks. Elicit the question: How did he do that with just two sticks?

Development:

1. Display transparencies of a ship sailing over the horizon and the phases of a lunar eclipse, (Figures 1 and 2).

2. Eratosthenes lived many centuries before Columbus. Why did he (and many others) believe that the Earth was round? (A ship seems to drop below the horizon as it sails away.) (During a lunar eclipse, the shadow of the Earth appears round.)

3. Put a small lump of clay on each piece of cardboard. Set a stick upright in each one. Shine a flashlight directly down on one of the sticks and point out the absence of a shadow. Begin tilting the flashlight and have students observe the shadow formed by the stick. Explain that these rays are slanted, rather than direct.

4. How does slanting the rays affect the shadow? (The more slanted the rays are, the longer the shadow.)

5. Tell the class that Eratosthenes knew of a certain place where, on a certain day of the year, a stick in the ground would have no shadow at Noon (indicate one of the sticks in the cardboard). At the same time, however, a stick many miles to the North did have a shadow.

6. How did the Sun's rays differ in the two places? (The rays near the first stick were direct, the rays to the North were slanted.)

7. Take the sticks and clay off the cardboards and put them on the globe (as in Fig.3). Elicit from the students that the shape of the globe is a sphere. Shine the flashlight directly on the stick near the Equator. Then, keeping the flashlight parallel, move it upwards so that it shines on the second stick.

8. Why does the second stick have a shadow?
   (The rays there are more slanted.)

9. Display transparency of Figure 3. How does this show that the Earth is a sphere? (The land far away from the Equator is tilted away from the Sun.)

10. Draw in the dotted lines and the two angles, as shown in Figure 3.
    How does Angle A change as the stick is moved away from the Equator?
    (The angle gets greater.)

11. For convenience sake, assume that the two sticks are 5,250 kilometers apart. This makes Angle A equal to 45 degrees. Point out that this is equal to Angle B. Fill in these values on the diagram.
    What fraction of the Earth's circumference does this represent?
    (Remind students that a full circle has 360 degrees. Angle B therefore represents one eighth of the circumference.)

12. Put the following data on the board:

    5,250 km = 1/8 Circumference of Earth

    Circ. =(Pi) x Diam. (Pi = 3.14)

    Using this data, have students calculate the full circumference of the Earth and the approximate diameter:

    Approximate Circumference; 42,000 km

    Approximate Diameter; 13,000 km

Summary:

Have students write a paragraph answering the question elicited by the motivation.

Application:

Display photograph of Earth taken by an astronaut or a satellite (one that shows the edge of the Earth.)

- Eratosthenes was never able to prove that the Earth was a sphere.
  How do photographs like these prove it?
  (The edge of the Earth is curved.)

Assignment:

1. Describe one observation that seems to indicate that the Earth is a sphere.
2. What is the approximate diameter and circumference of the Earth?
3. How does the angle of the Sun's rays change as you move away from the Equator?

Fig. 1 - A Ship Sailing Away

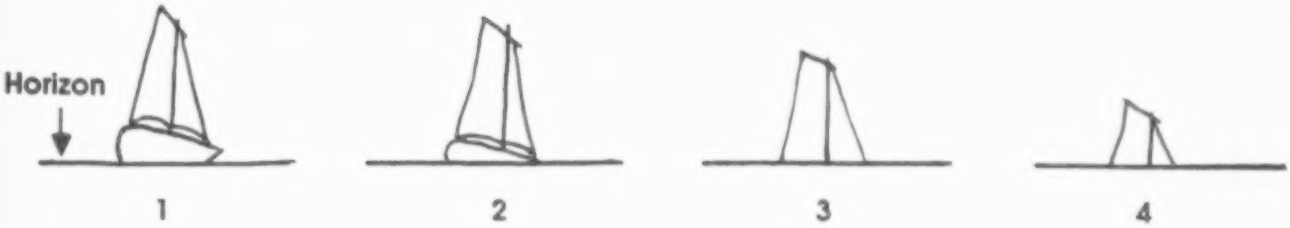

Horizon
1
2
3
4

Fig. 2 - A Lunar Eclipse

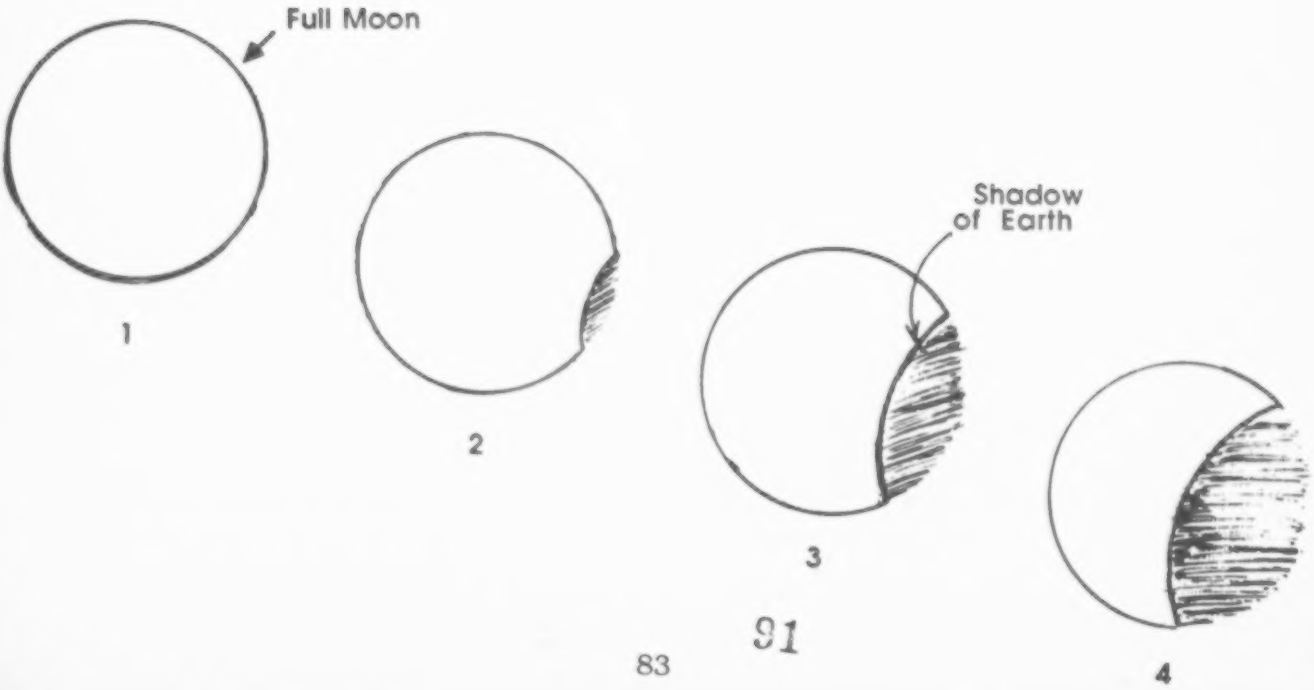
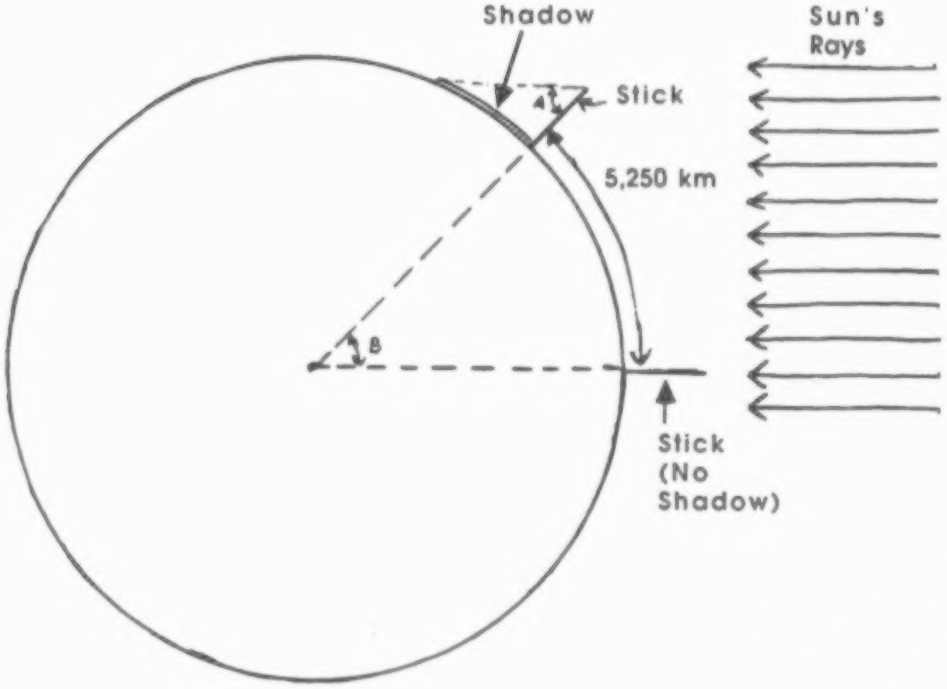

Full Moon
Shadow of Earth
1
2
3
4

Fig. 3 - Eratosthenes' Method for Calculating the Circumference of the Earth


Shadow
Sun's Rays
Stick
A
5,250 km
B
Stick (No Shadow)

TOPIC 23 - Rotation of Earth

Aim: Why do we experience day and night?

Performance Objectives: Students will be able to:

- explain why the Sun rises in or near the east and sets in or near the west
- describe the position of Earth's Axis relative to Sun's rays
- explain why the Polar regions do not experience 24-hour cycles of light and darkness

Materials:

Gooseneck lamp, orange, sharp pencil, black felt-tip pen, transparency projector, transparency of Figure 1., chalk globe, current newspaper

Motivation:

Display the weather column from the day's newspaper. Have students note the local time of sunrise and sunset. Tell the students "At the North Pole, the Sun did not (rise/set)* at all today." Elicit the question; Why didn't the Sun (rise/set)* at the North Pole today?"

Development:

1. Push the pencil completely through the middle of the orange. Draw an "X" on the orange to indicate the location of the class on the globe. Darken the room and turn on the lamp. Hold the orange with the axis slightly tilted and with the "X" pointed toward the lamp. Ask the class:

2. Why can't everybody in the world see the Sun?
   (One side of the world faces away from the Sun.) .
   Why was it dark here twelve hours ago?
   (At that time, we were facing away from the Sun.)

3. Turn the orange to indicate position of class twelve hours previous to the lesson, then rotate the orange back to the original position.

4. Why will we again be in darkness soon?
   (We will again be facing away from the Sun.)

5. Rotate the orange until the "X" is again facing away from the lamp. Ask the class:

6. Why do we have these cycles of day and night?
   (The Earth is turning.)

* For the MOTIVATION:

If this lesson is taught before the Autumnal Equinox (about Sept 21) or after the Spring Equinox (about March 21), the Sun did not SET. If it is taught between these dates, the Sun did not RISE.

7. Identify the pencil as Earth's AXIS, an imaginary line. Define ROTATION as the turning of Earth on its axis.

8. How do we know that one rotation takes about 24 hours? (That is how long one day and night is.)

9. Place the chalk globe next to the lamp and establish the directions north, south, east and west. Explain to the class that the Sun appears to rise in or near the east and set in or near the west. On that basis, have a volunteer establish the direction of rotation (west to east.)

10. Why is it a mistake to say that the Sun is "rising"? (In reality, it is the Earth that moves relative to the Sun.)

11. Display the transparency of Figure 1. Point out that the Circle of Twilight divides the daylight from the darkness. This dividing line is perpendicular (straight up and down) relative to the Sun's rays.

12. What time of day is it at Points A, B, and C? (Students should recognize that it is morning--not evening--at Point B.) How is the position of the Axis different from the position of the Circle of Twilight? (The axis is tilted.)

    Explain that the Axis of Earth is tilted 23 degrees away from the Circle of Twilight.

13. Mark points A, B, C and D on the chalk globe. Rotate the chalk globe in front of the lamp.

14. If you were standing at point D, why would you have 24 hours of darkness? (Point D does not cross the Circle of Twilight.)

15. Identify the Arctic and Antarctic Circles on Figure 1. Draw them on the chalk globe. At the time of the year shown on Figure 1. (around Dec 21) the land above the Arctic Cricle is pointed away from the Sun, and therefore experiences 24-hour darkness.

16. Why does Point E experience 24-hour daylight? (The Antarctic region is pointed toward the Sun.)

17. Display Figure 2., which shows the position of Earth around June 21. Change the position of the chalk globe to correspond to this.

18. How are Points D and E different now than six months before? (Point D has 24-hour daylight and Point E has 24-hour darkness.)

Summary:

How do we know that it takes 24 hours for the Earth to complete one rotation?
(That is how long it takes to go through one cycle of daylight and darkness.)

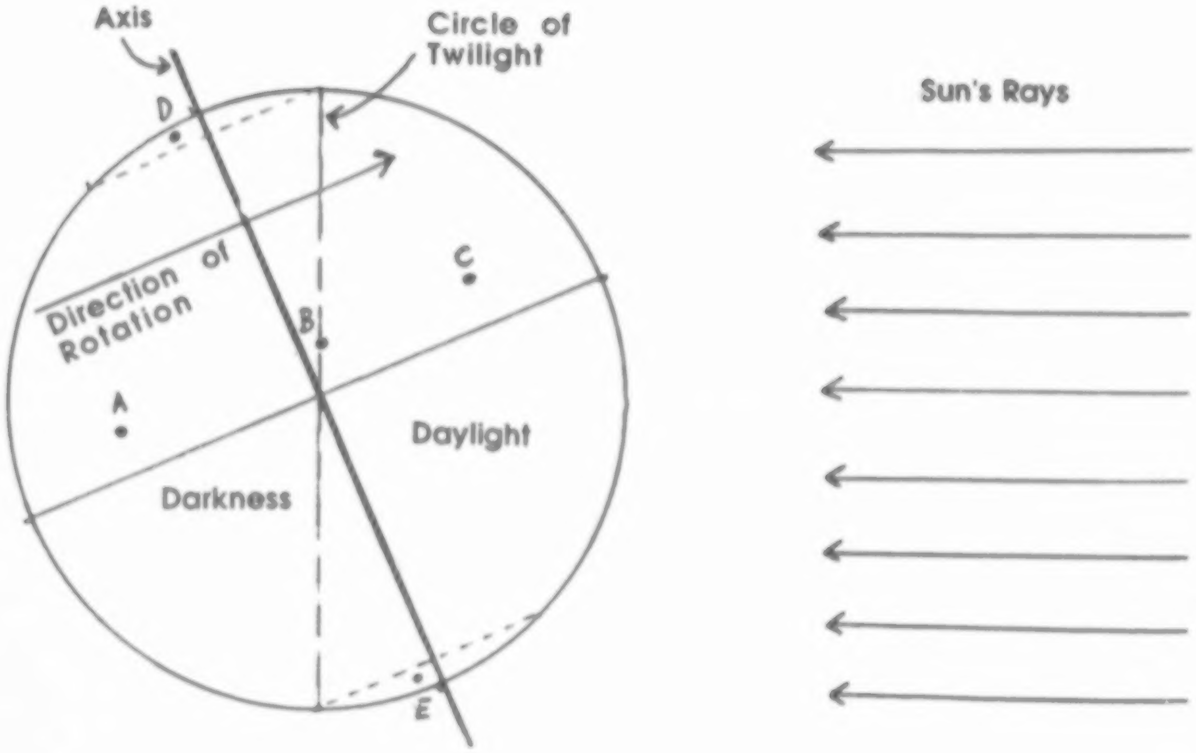
Application:

Every year on June 21 they play a special baseball game in Fairbanks, Alaska. This game begins at 12 Midnight. Why are they able to play at that hour?

Assignment:

1. What is rotation?
2. Why does the Sun appear to rise near the East and set near the West?
3. Why don't the Polar regions experience regular cycles of daylight and darkness?

Fig. 1


Axis
Circle of Twilight
Sun's Rays
D
C
B
A
E
Direction of Rotation
Daylight
Darkness

TOPIC 24 - Effects of Rotation

Aim: How does the rotation of Earth affect us?

Performance Objectives: Students will be able to:

- state that the apparent motion of the Sun, stars, planets and Moon are caused by the rotation of Earth
- explain the motion of a Foucault pendulum in terms of the Earth's rotation

Materials:

Diagram or model of Foucault pendulum, pencil on a string, typing paper, glass funnel, beaker, ring stand with one ring, chalk globe, chart of planetary winds.

Motivation:

Many ancient civilizations thought that the Sun and stars moved around the Earth. Now however, we know that these heavenly bodies are actually standing still. Elicit the question: Why do the Sun and stars appear to move?

Development:

1. Hold the pencil on a string over the typing paper and allow it to swing freely.
2. What sort of a mark will appear on the paper? (Draw a vertical line on the board.)
3. Rotate the paper underneath the swinging pencil about 30 degrees.
4. How will the mark be different now? (Have volunteer draw another line on the board at an angle to the original line.)
5. If students have difficulty visualizing this, repeat the demonstration, rotating the paper to 60 degrees, 90 degrees, 120 degrees, etc. Add the corresponding lines to the diagram on the board.
6. If we rotate the paper around completely, what sort of a pattern will the pencil leave on the paper? (Have students draw the imagined pattern in their notebooks. It should be a "star" pattern, like a giant asterisk.)
7. Display the model or diagram of the Foucault pendulum. This pendulum was so large--and its metal bob so massive--that, once started, it would keep swinging for over 24 hours.
8. Foucault hung this pendulum from the ceiling of the Pantheon building in Paris and allowed it to swing freely for a full day. At the end of that time, he found that the pendulum had traced the full "star" pattern on the paper beneath it.

9. How can we explain these results?
   (Have students write their own hypotheses.)

10. Emphasize that during the day Foucault did not touch either the pendulum or the paper. The pendulum was indoors, and therefore could not have been blown by the wind. Under these conditions a weighted pendulum does not change its direction of motion.

11. How else could we explain the results?
    (The paper rotated under the pendulum.)
    No one touched the paper. How did it rotate? (The Earth rotated.)

12. Display the chart showing the planetary winds. Review the Coriolis effect with the class.

13. Why do the winds bend from their original direction?
    (This is caused by the rotation of Earth.)

14. Set the glass funnel in the ring of the ring stand. Put the beaker under the funnel. Pour a trickle of water into the funnel and have the students note the direction in which it is bent as it flows down the funnel. In the Southern Hemisphere, the water would be bent in the opposite direction.

Summary:

1. How do we know that the Earth is rotating?

   a. A Foucault pendulum traces a full circular pattern in 24 hours.
   b. The planetary winds are bent to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.
   c. Flowing substances, such as water are bent in opposite directions in the Northern and Southern Hemispheres.)

Application:

Why do the Sun and stars seem appear to move?
(The Earth is rotating.)

Assignment:

1. Why did many ancient civilizations think that the Earth stood still and the Sun and stars moved?

2. How does a Foucault pendulum show that the Earth is rotating?

3. How does the rotation of Earth affect the planetary winds?

TOPIC 25 - The Earth's Orbit

Aim: How do we know that the Earth orbits around the Sun?

Performance Objectives: Students will be able to:

- define revolution and orbit
- explain why certain stars can be seen only at certain times of the year

Materials:

Mechanical orbital model of Earth and Sun, star chart of Winter sky and Summer sky, transparency projector, transparency of Figures 1, 2 and 3

Motivation:

Indicate a "Winter" star on the seasonal star chart. Ask a volunteer to try to find it on the Summer portion of the chart. Elicit the question: Why can't we see this star in the Summer?

Development:

1. Display Figure 1. (Note: On this and all subsequent diagrams, sizes and distances are not drawn to scale.)
2. Why can we see star A, but not star B? (The glare from the Sun blocks our view)
3. Display Figure 2.
4. Why can we see star B now? (The Earth is now on the other side of the Sun.)
5. Relate these observations to the seasonal star chart. Have students identify three Winter stars and three Summer stars. Display Figure 3. Fill in the three Winter stars on the left side of the transparency and the three Summer stars on the right side.
6. Why will the three stars near star A be visible again in six months? (The Earth will be back to its original position.)
7. If an object as large as the Earth is moving, it must be moving with a great amount of force. This force is called INERTIA. This inertia would tend to keep the Earth moving in a straight-line direction. Instead, the Earth returns to a place it occupied a year before.
8. Why doesn't the Earth keep moving in the same direction? (The gravity of the Sun pulls it back.)
9. These two forces (the Earth's inertia and the Sun's gravity) are always being exerted on the Earth.

10. How do they affect the motion of the Earth?
(They cause the Earth to move around the Sun.)

11. Have students look up REVOLUTION and ORBIT in their textbooks. One complete revolution of Earth takes 365 and 1/4 days.

12. What is a YEAR? (A year is the time required for the Earth to complete one revolution around the Sun.)

13. The spots marked "x" on the Figure 3 indicate our position on Earth.

14. Why is star C visible to us all year round?
(Its position is above the orbit of Earth.)

15. Indicate such a star on the star charts?

16. Why does its position seem to change during the year?
(We see it from different angles each season.)

17. Find a star on the chart whose position changes less than the star just noted. Call it star D. Display Figure 4.

18. Why does the position of star D change less during the year than Star C?
(It is farther from the Earth than star C.)
How can astronomers tell which stars are further from the Earth than others?
(The more their apparent positions change, the nearer they are to Earth.)

19. Indicate Polaris on Figure 4.

20. Why is this star visible all year in the Northern Hemisphere?
(The Northern Hemisphere is pointed directly towards it.)
Why is it never visible in the Southern Hemisphere?
(The Southern Hemisphere is pointed away from it)

Summary:

Why are many stars visible only at certain times of the year?
(The position of the Earth changes due to its rotation around the Sun.)

How do we know that one year lasts approximately 365 days?
(Most stars follow a regular pattern of change bringing them back to their original position in 365 days.)

Application:

In ancient times, people did not know that the Earth revolved around the Sun. How, then, did they know that a "year" lasts 365 days?
(They observed the stars.)

Assignment:

1. What is the difference between rotation and revolution?
2. What are the two basic forces that cause the Earth to revolve around the Sun?
3. Why are some stars visible all year long, while other stars are only visible during certain months?

Fig. 1 (January)

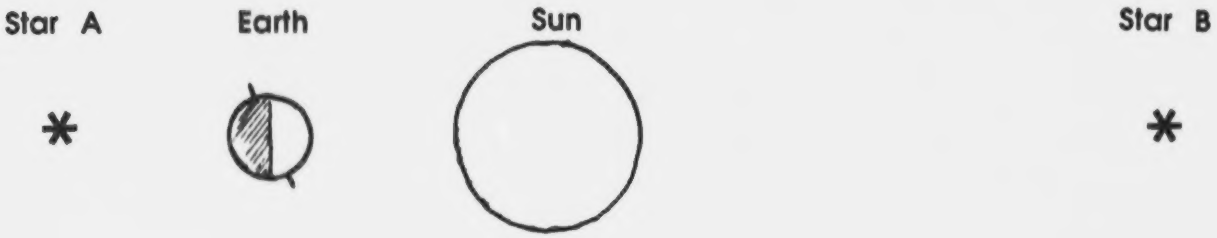

Star A
Earth
Sun
Star B

Fig. 2 (July)

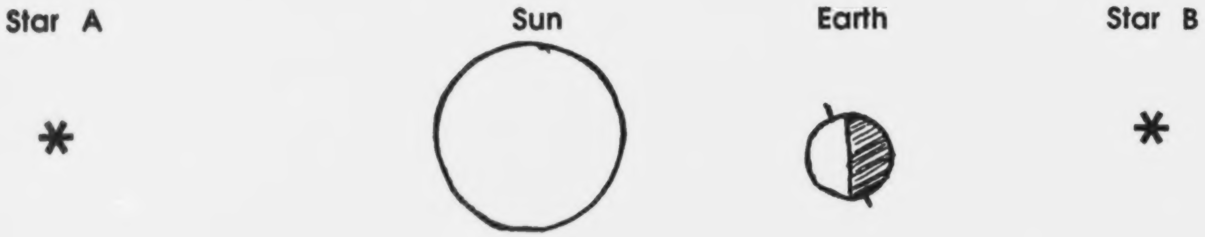

Star A
Sun
Earth
Star B

Fig. 3

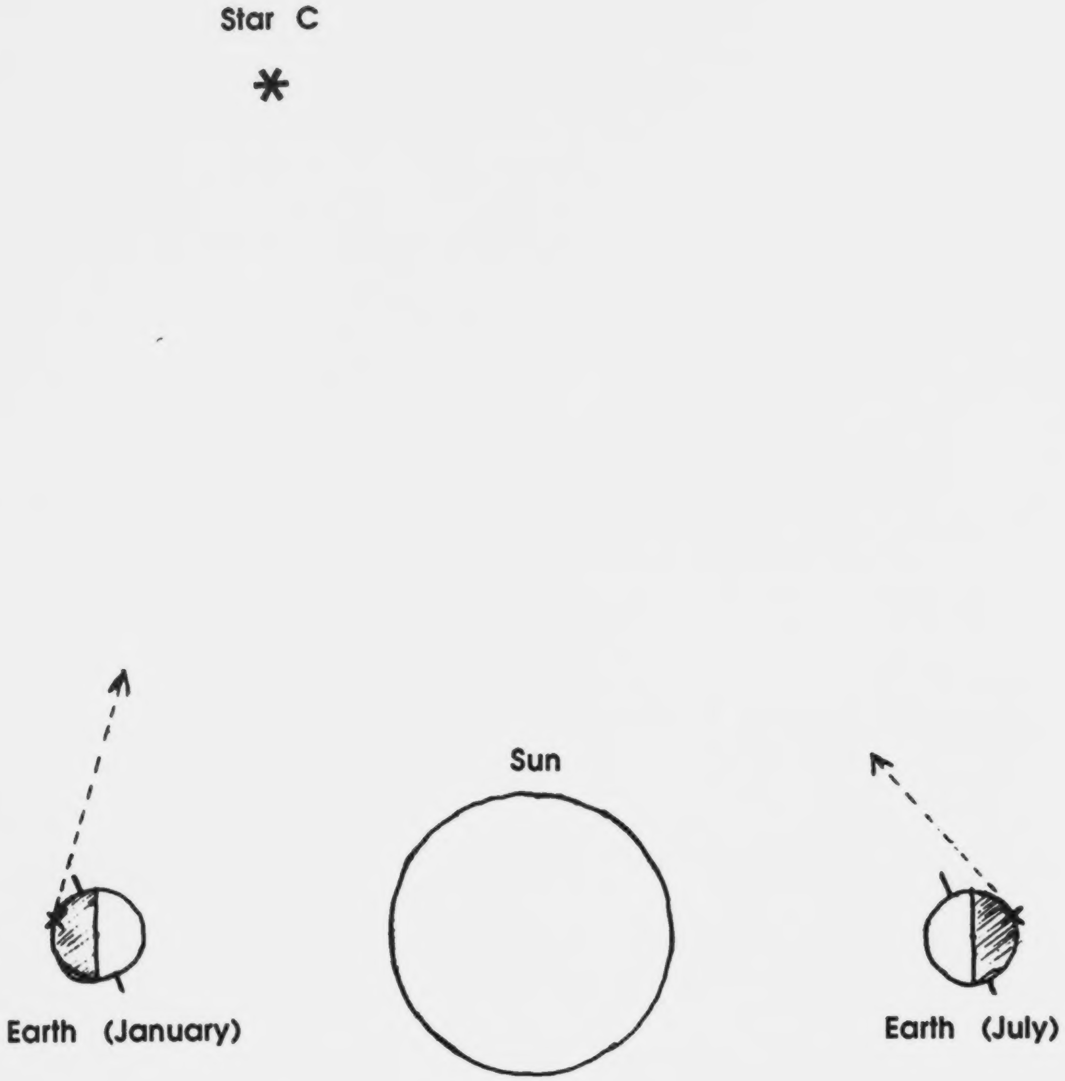
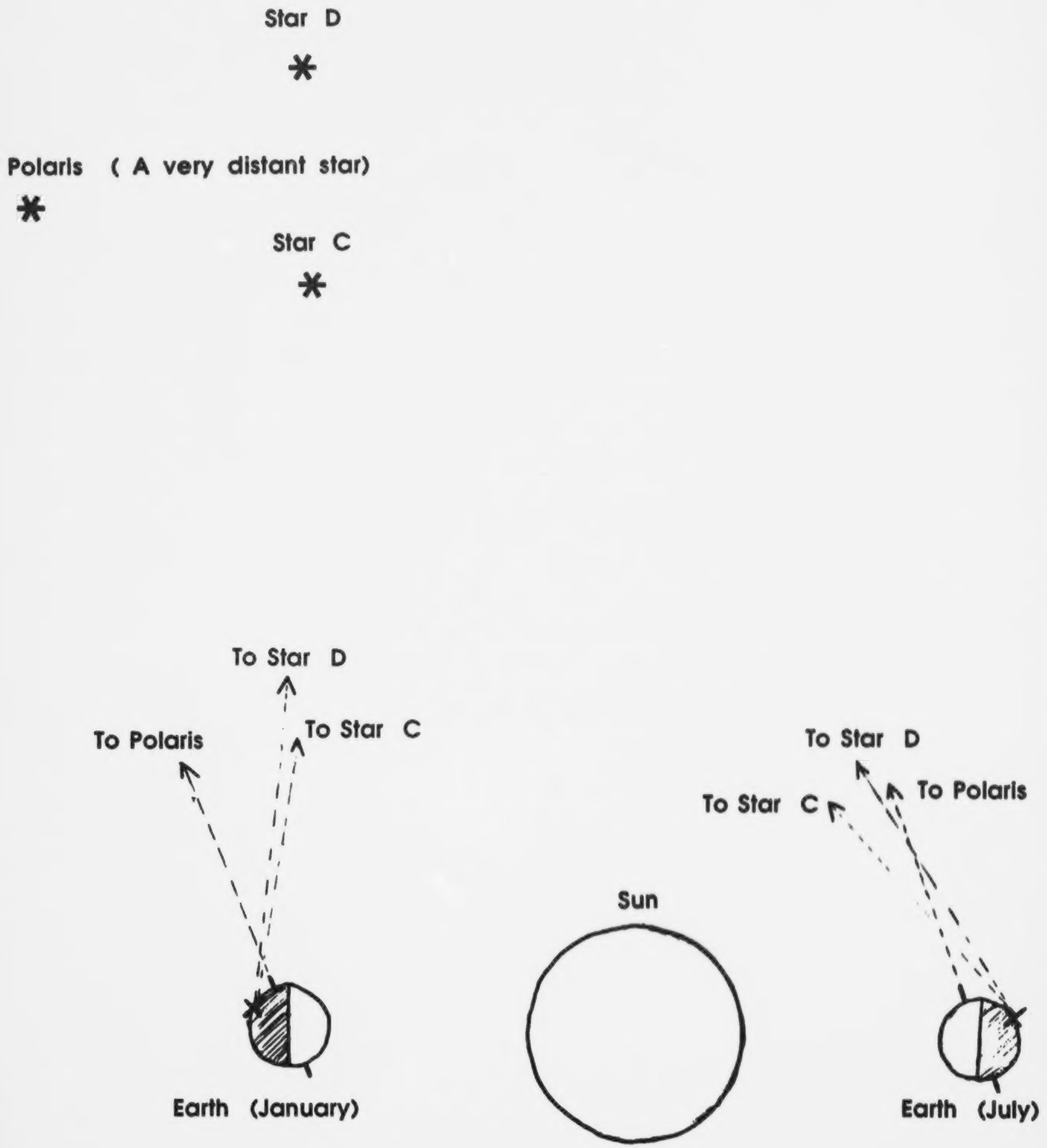

Star C
Sun
Earth (January)
Earth (July)

Fig. 4


Star D
Polaris (A very distant star)
Star C
To Star D
To Polaris
To Star C
To Star D
To Polaris
To Star C
Sun
Earth (January)
Earth (July)

TOPIC 26 - The Earth's Revolution (Seasons)

Aim: How does the Earth's revolution affect the seasons?

Performance Objectives: Students will be able to:

- identify the season given a location on a diagram of the Earth and the Sun
- explain why the tropics experience perpetual warmth and the poles experience perpetual cold
- explain why the Southern Hemisphere and the Northern Hemisphere experience opposite seasons

Materials:

Gooseneck lamp, thermometer, black paper, small protractor, ruler, chalk globe.

Motivation:

Explain that the Earth is closest to the Sun (approx. 91 million miles) in December. Elicit the question: Why is it cold during that month?

Development:

1. Position the gooseneck lamp approximately 5 or 6 inches directly above the black paper. Place the thermometer under the paper and turn the lamp on. Record the temperature of the paper after two minutes.

2. Allow the paper to cool, then repeat the experiment with the lamp at an angle to the paper. Use the ruler to place the angled lamp at the SAME DISTANCE from the paper as in the first experiment. Record this second temperature after two minutes.

3. Why didn't the paper become as warm the second time?
   (The lamp was slanted the second time.)

4. Recall from Lesson 1 that the Sun's rays can be DIRECT or SLANTED when they strike the Earth.

5. How do the effects of these rays differ?
   (The direct rays warm the Earth more than the slanted rays.)

6. Point the gooseneck lamp directly at the chalk globe, with the Northern Hemisphere pointed AWAY from the lamp. Draw a circle on the board to represent the Earth. Draw an arrow to represent a ray from the Sun striking the Equator and another arrow to represent the Sun's ray striking New York's approximate location, as in Figure 1. Have a student measure the approximate angle of the two rays with the protractor.

7. Why will the second location be colder than the Equator?
   (This location is receiving slanted rays, while the Equator is receiving direct rays.)

8. Draw a third line to represent a ray striking a location farther north than New York, as in Figure 1.

9. Why will this location be even colder than New York? (The rays striking this location are more slanted.)

10. Mark these three locations on the chalk globe.

11. How will the position of the Earth be different in six months? (It will be on the other side of the Sun.)

12. Turn the lamp 180 degrees and move the globe around to the other side of the table, taking care to keep the axis pointed in the same direction as before.

13. How has the position of the Axis changed, relative to the Sun? (Before it was tilted away from the Sun, now it is tilted toward the Sun.)

14. Draw the corresponding diagram on the board (Figure 2). At this time of the year the Sun is at its farthest point from the Earth (approx. 94 million miles.)

15. Why does our location experience temperatures at this time?
    (The Sun's rays are now more direct on our area.)
    Why are the Summers cooler in areas North of us?
    (The rays that strike these areas are more slanted.)
    Why is it ALWAYS cold in the Arctic region, even in the Summer months?
    (This area only receives slanted rays.)
    Why is it ALWAYS warm in the tropics?
    (This area always receives direct, or nearly direct rays.)
    Why is it Winter in the Southern Hemisphere when it is Summer in our area?
    (At that time, the Southern Hemisphere is tilted away from the Sun, so it receives slanted rays.)

Summary:

Why do we have our warmest weather in June and July, even though the Earth is at its greatest distance from the Sun at that time?
(At that time, the Northern Hemisphere is tilted toward the Sun, so that we receive more direct rays from the Sun.)

Application:

Tasmania, an island nation in the Southern Hemisphere, is located approximately the same distance from the Equator as is New York. Why do Tasmanians flock to the beaches every Christmas?

Assignment:

1. How do the Sun's rays in Winter differ from the Sun's rays in Summer?
2. Why do people in Equatorial Africa divide the year into a Dry season and a Rainy season, rather than Winter, Spring, Summer and Autumn?
3. Many nations send expeditions to explore Antarctica. Why can these expeditions be conducted only from November to March?

Fig. 1 (December 21)

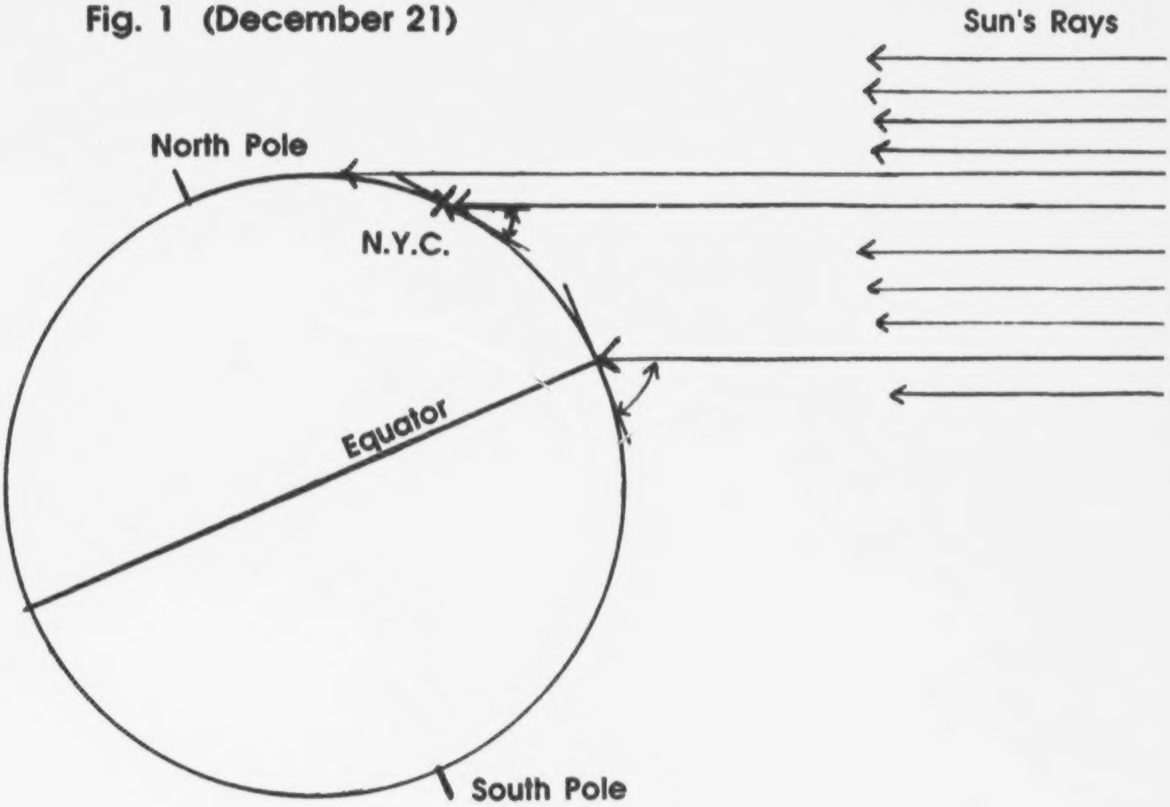
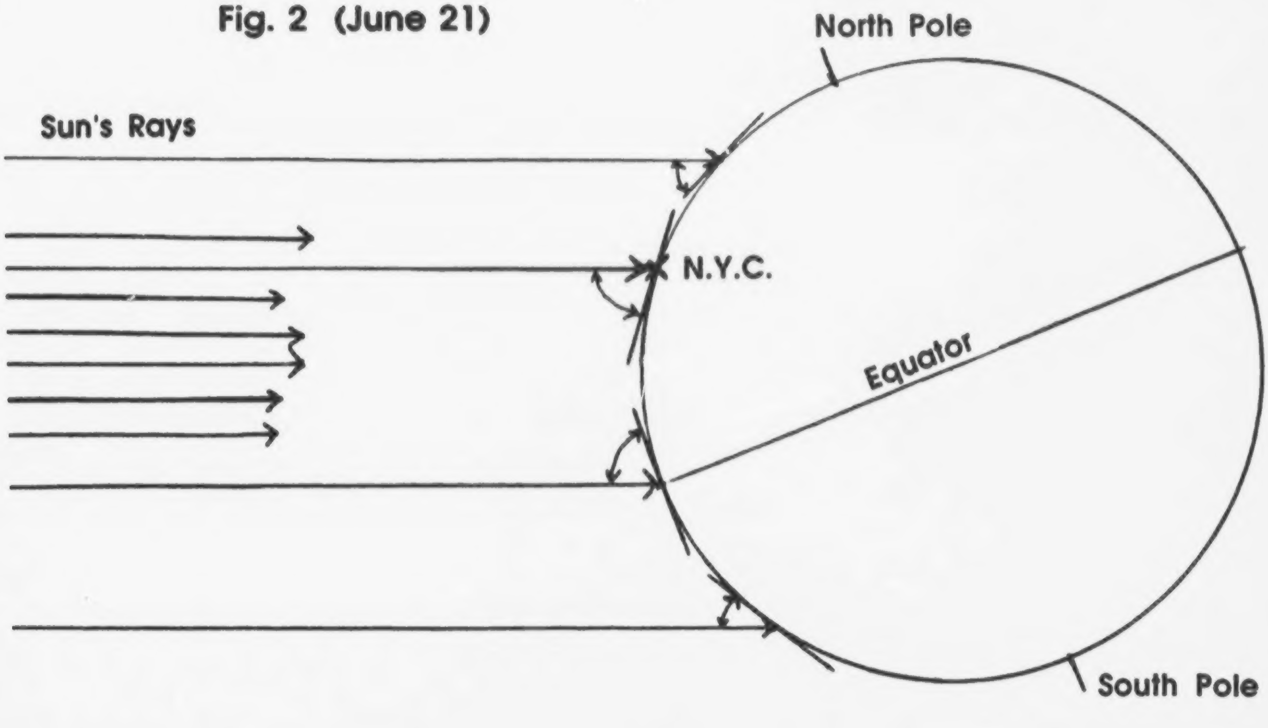

Sun's Rays
North Pole
N.Y.C.
Equator
South Pole

Fig. 2 (June 21)


North Pole
Sun's Rays
N.Y.C.
Equator
South Pole

TOPIC 27 - The Earth's Revolution (Daylight)

Aim: Why does the length of daylight change through the year?

Performance Objectives: Students will be able to:

contrast the yearly daylight pattern of their own location with that of the Equator, the Poles and the Southern Hemisphere.

Materials:

World map, chalk globe, transparency projector, transparencies of Figures 1 and 2, newspapers from three consecutive days.

Motivation:

Have students read the weather columns from the three newspapers. Record the times of sunrise and sunset on the board. Elicit the question: Why are the periods of daylight getting shorter (or longer)?

Development:

1. Display Figure 1. Set up the chalk globe and the lamp to correspond to the diagram. Mark Points A, B, and C on the globe.
2. Why does Point A experience 12 hours of daylight and 12 hours of darkness?
   (The path of Point A is half in daylight and half in darkness.)
3. Why does Point B experience LESS than 12 hours of daylight?
   (The path of Point B is mostly in darkness.)
4. How is a day at Point C different from a day below the Arctic Circle?
   (Point C has no daylight at all.)
5. So how does the location of a point on this diagram affect the amount of daylight it receives?
   (The farther North it is, the less daylight it receives.)
6. Display Figure 2. Move the globe to the other side of the lamp, while keeping the axis pointed in the same direction.
7. How is the path of Point B different on this day than on December 21?
   (The path of Point B is mostly in daylight, rather than mostly in darkness.)
8. How does this affect the length of daylight at Point B?
   (Point B will have more than 12 hours of daylight.)
9. How will it be different six months from this date?
   (The path will again be mostly in darkness and Point B will have less than 12 hours of daylight.)

Note: If this lesson is taught between Dec 21 and June 21, use the underlined terms, otherwise use the terms in brackets;

10. So why are the periods of daylight getting longer [shorter] each day? (The Earth is currently moving toward the position in Figure 2 [1]).

11. After the Earth passes this point in its orbit, how will the periods of daylight change? (They will begin to get shorter [longer].)

12. How is the daylight on June 21 different from the rest of the days in the year?
(On that day we receive the longest period of daylight.)

13. Explain that this phenomenon is called the Summer Solstice. It occurs on June 20 or 21. For this reason, the day of the Solstice is considered the first day of Summer.

14. Why is December 20 or 21 considered the first day of Winter?
(On that day we receive the shortest amount of daylight. This phenomenon is called the Winter Solstice.)

15. Have students summarize the yearly changes in daylight hours in New York. Emphasize that in the Spring and Summer, each day has a longer period of daylight than darkness. In the Fall and Winter, the reverse is true.

16. The first days of Spring and Fall are called the Equinox, meaning "equal night".

    Why are these days called by such a name?
    (On these days the period of daylight is equal to the period of darkness.)

17. Display Figure 2 again.

    Why does Point A still receive only 12 hours of daylight on this date?
    (The path of rotation is still only half in daylight.)

18. How is the yearly pattern of daylight different at the Equator than it is here?
(The Equator receives 12 hours of daylight every day of the year.)

19. Why does Point C receive 24 hours of continuous daylight on this day?
(The path of rotation for this point is entirely in daylight.)

20. Draw a Point D on the globe in the Southern Hemisphere, at about the same distance from the Equator as Point B.

21. How is the yearly daylight pattern at this point different from ours?
(At this point, the pattern is the exact opposite of ours. The daylight hours get longer when ours are getting shorter and vice versa.)

Summary:

Why does the Winter Solstice occur in June in the Southern Hemisphere? (At that time the Southern Hemisphere is tilted away from the Sun, rather than towards it.)

Applications:

Most flowering plants bloom during the Spring. Often a florist or a botanist will "force" such a plant to bloom before its natural time. The plant is placed in a room with a light bulb and the light bulb is turned on for longer and longer periods each day.

1. Why does this cause the plant to bloom?

2. How would you "force" a plant that normally blooms in the Fall?

Assignment:

During the Winter the periods of daylight are:
a) less than 12 hours long
b) getting longer.

1. How does this compare with the periods of daylight in the Spring? The Summer? The Fall?

Fig. 1 (December 21)

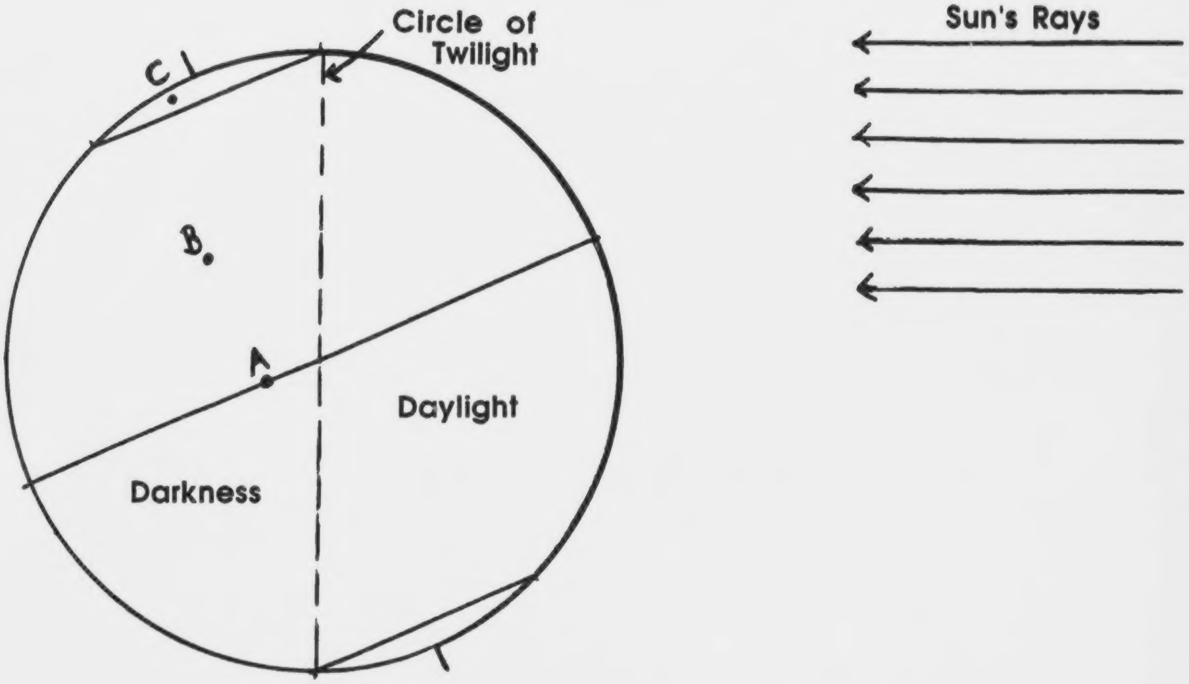
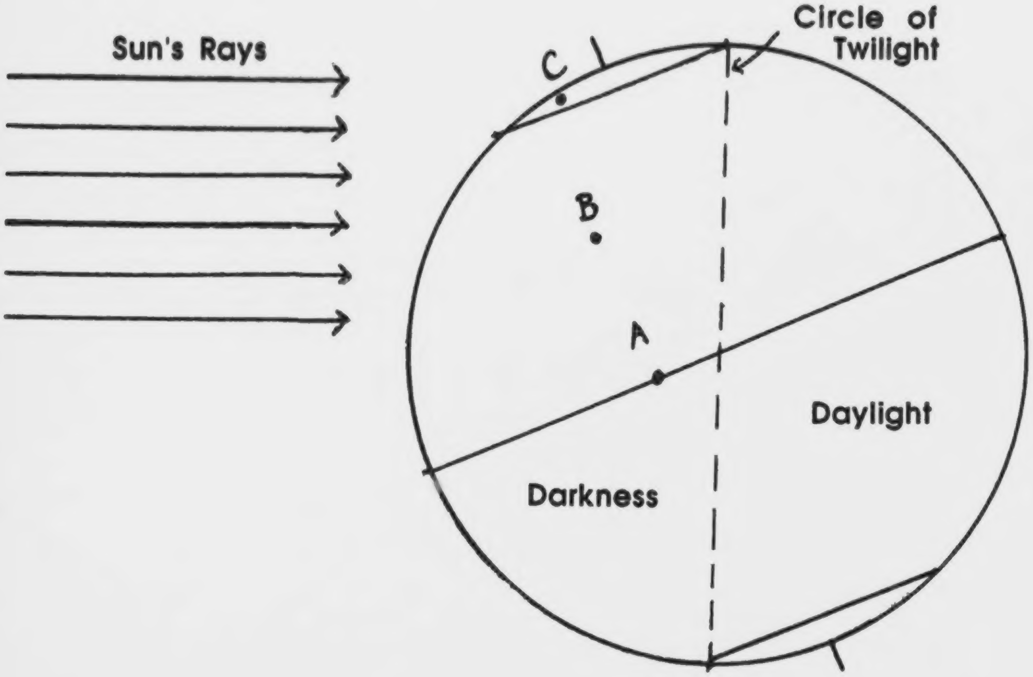

Circle of Twilight
Sun's Rays
C
B
A
Daylight
Darkness

Fig. 2 (June 21)


Sun's Rays
Circle of Twilight
C
B
A
Daylight
Darkness

TOPIC 28 - Determining Location

Aim: How can we determine where, in the World, we are?

Performance Objectives: Students will be able to:

- . explain two ways to determine which direction is North.
- . state the longitude and latitude (within five degrees) of a given point on a map.

Materials:

World map, map of U.S.A., magnetic compass, star chart showing Polaris, transparency projector, transparency of Figures 1 and 2, chalk globe.

Motivation:

Point out to the class that sailors have always had one problem that land travelers did not: there are no landmarks (such as mountains) in mid-ocean to indicate where they were. Elicit the question: How do sailors know where they are?

Development:

1. Display the compass.
   How could this help the sailors?
   (The needle of the compass always points North.)

2. Once you know North, how do you find the other directions?
   (If you face North, South is to your back, East is to your right and West is to your left.)

3. Emphasize that the needle points to a direction that is not True North. This direction is called Magnetic North. Magnetic variation is the angle by which the compass needle varies from True North.

4. Display the star chart. Show how Polaris can be located using the two "pointers" of the Big Dipper. Then display Figure 1.

5. What is unique about the star, Polaris?
   (It is in line with Earth's axis.)

6. If you were at the North Pole, how would you recognize Polaris?
   (It is directly overhead.)

7. How would its position change as you go South?
   (As you go South, Polaris gets lower in the sky.)

8. So how can this star help sailors determine their location?
   (Polaris indicates which way North is. The higher it appears in the sky, the farther North you are.)

9. Why must sailors use other stars to find their location South of the Equator?
   (Polaris is not visible in the Southern Hemisphere.)

10. Display Figure 2, showing parallels of Latitude. Compare this with the maps of the World and the United States.

11. How do the numbers of the parallels change as you go from the Equator to the North Pole?
    (They increase from zero to 90 degrees North.)

12. How are the parallels South of the Equator different from this?
    (Those parallels are designated "South".)

13. Display the map of the U.S.A.
    What is the approximate Latitude of New York City?
    (Most students will give an answer between 40 and 42.)

14. Indicate Wellington, New Zealand on the World map.
    This city also has a Latitude of 42 degrees. How can you tell the difference between the two locations?
    (New York is at Latitude 42 degrees North. Wellington is at 42 degrees South.)

15. Have students study the World map and name three other cities that have about the same Latitude as New York City.
    (Madrid, Rome, Istanbul, Peking, Chicago)

16. Point out that Latitude only indicates locations North and South. To determine locations East and West, you need two clocks.

17. Display Figure 3.
    How can the shadow of the stick tell you when it is Noon?
    (At Noon, the stick casts the shortest shadow.)

18. Explain that in past centuries, people would set their clocks by the Sun in this manner.

19. Draw three locations around the Equator of the chalk globe. Rotate the globe from West to East. Ask the class which of the three places will reach Noon first?

20. How will clocks in the three locations be different from one another?
    (The clocks at the point farthest East would show the latest time.
    The clocks farthest West would show the earliest time.)

21. Sailors used to take two clocks with them on their voyages. Clock #1 would be set to the time of the port city from which the ship sailed. Clock #2 would be re-set to the local time every day.
    How did this help sailors determine their location East or West?
    (If Clock #2 was ahead of #1, the ship was East of the port city. The greater the difference, the farther East they were. If #2 was behind #1, the ship was west of the port city.)

22. Indicate Meridians on the World map and on Figure 2. Have students note the range of the readings (zero to 180 degrees). Indicate that New York City and New Delhi, India have a Longitude of about 75 degrees.

23. How can you tell the difference between these two locations? (New York is 75 degrees West, New Delhi is 75 degrees East.)

24. Have students name other cities that have the same approximate Longitude as New York. (Montreal, Kingston, Bogota, Lima)

Summary:

New York City has a location of approximately 42 degrees N., 75 degrees W.

Study the World map and give the locations of the following places;

1. Honolulu, Hawaii -- (21 degrees N., 158 degrees W.)
2. Miami, Florida -- (25 degrees N., 81 degrees W.)
3. Rome, Italy -- (43 degrees N. 13 degrees E.)
4. Sydney, Australia -- (35 degrees S., 150 degrees E.)
5. Lima, Peru -- (13 degrees S., 77 degrees W.)

Application:

If you were lost, what are two ways you could determine which way North is? (Use a compass, or look for the "Dippers" and find Polaris.)

Assignment:

1. How can Polaris tell you how far North you are?

2. Which places on Earth have a Latitude of 0 degrees, 90 degrees N. and 90 degrees S.?

3. What is the difference between parallels and meridians?

Fig. 1

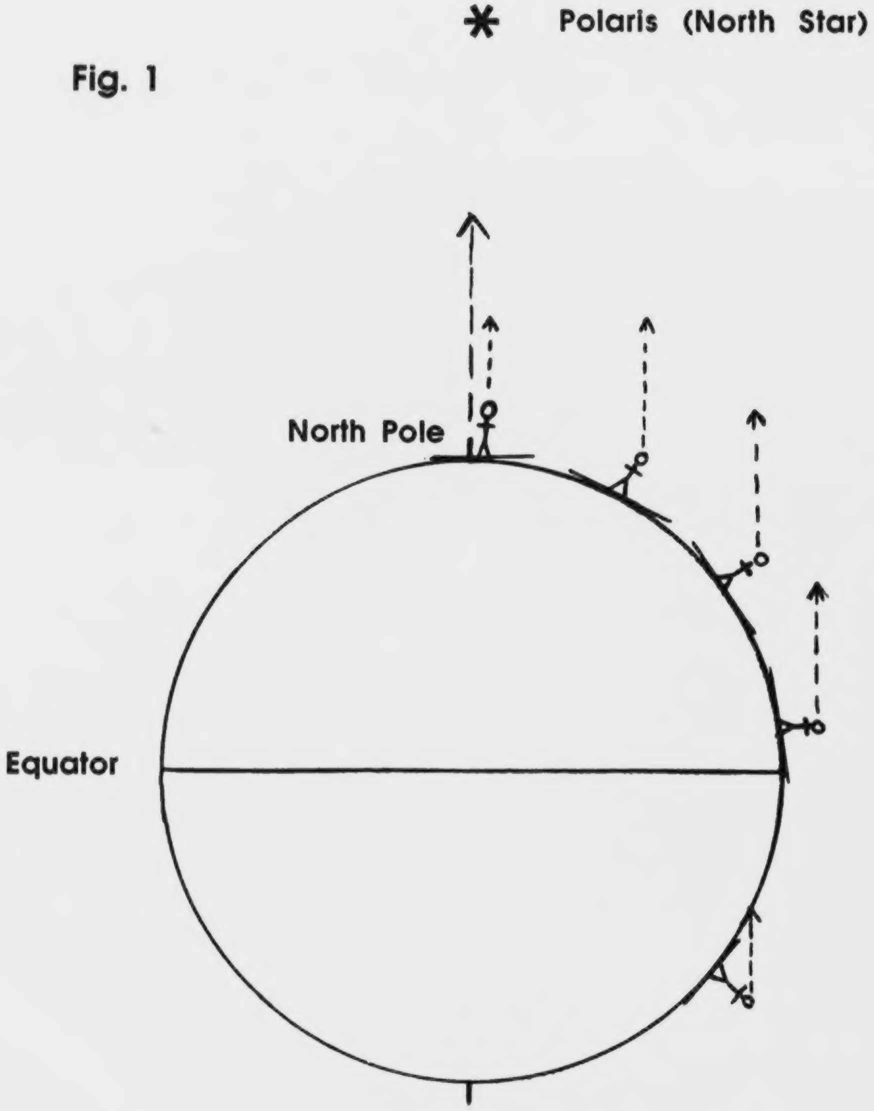

Polaris (North Star)
North Pole
Equator

Fig. 2 (Parallels of Latitude)

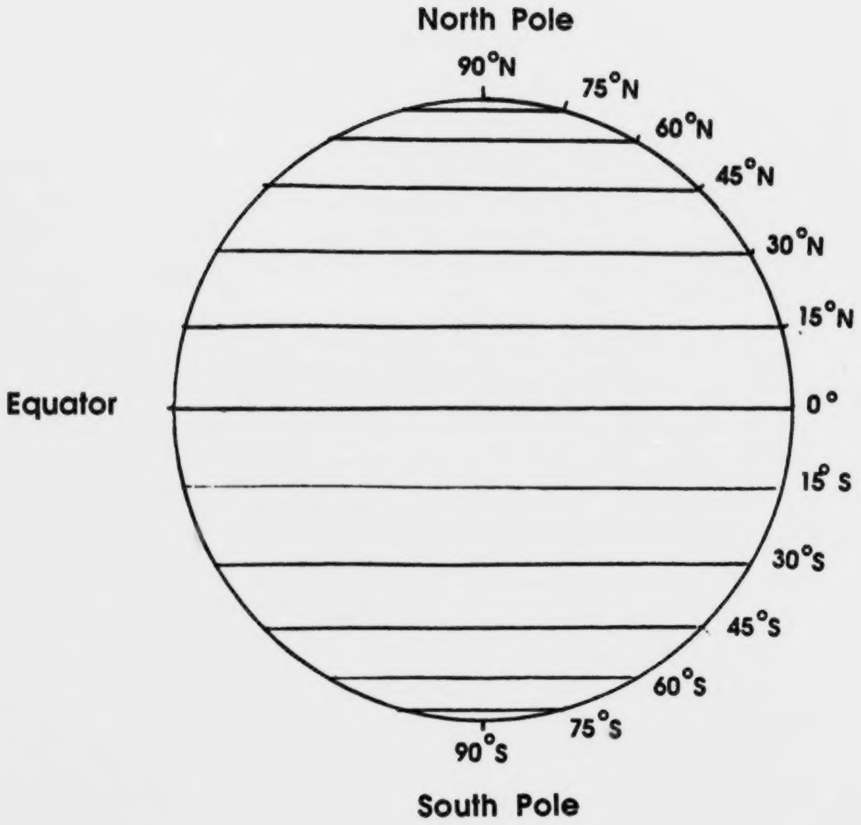
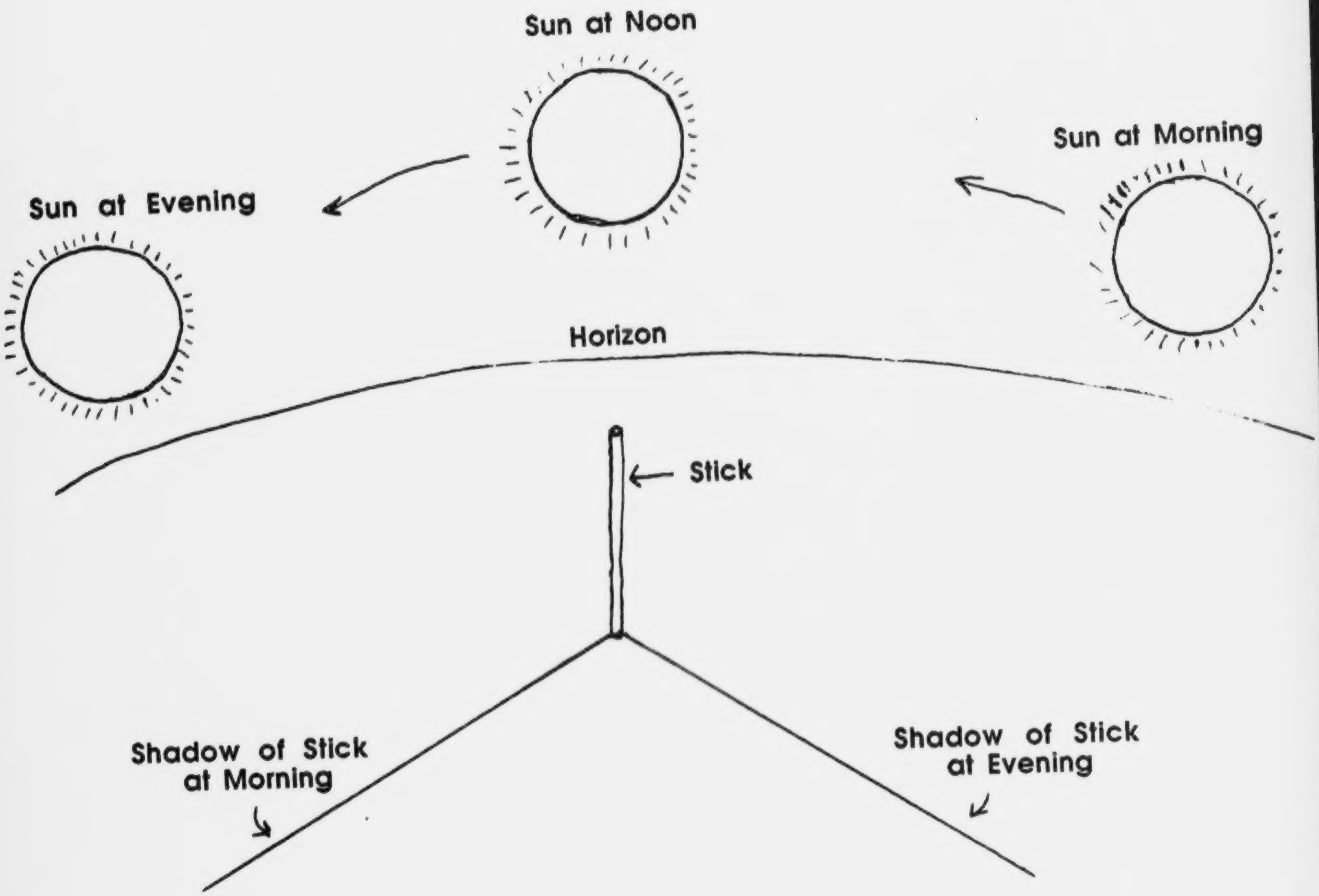

North Pole
90°N
75°N
60°N
45°N
30°N
15°N
Equator
0°
15° S
30°S
45°S
60°S
75°S
90°S
South Pole

Fig. 3


Sun at Noon
Sun at Morning
Sun at Evening
Horizon
Stick
Shadow of Stick at Morning
Shadow of Stick at Evening

TOPIC 29 - Determining Time

Aim: Why is the time different in different parts of the world?

Performance Objectives: Students will be able to;

- determine the time in one time zone given the time in another zone.
- explain how the time changes as location changes (east and west).

Materials:

Time zone map of U.S.A, time zone map of World, transparency projector, transparencies of Figures 1 and 2, sundial, chalk globe.

Motivation:

People used to use the Sun to tell the time and to determine how to set their clocks. Ever since the railroads were built this method has been unsatisfactory. Now we have to set our clocks by a different method.
Elicit the question: Why must we use a different method?

Development:

1. Display the sundial.
   How could this object tell you the time of day?
   (The shadow of the Sun changes as the day goes by.)

2. How can you tell when it is Noon?
   (At Noon, the shadow cast by the sundial is the shortest.)

3. Explain that one solar day is the period of time from one Noon to the next. This period is divided into 24 hours.

4. Display Figure 1.
   How is the time of day different in these three locations?
   (It is before Noon at Point A, and afternoon at Point C.)

5. Why would Point B and Point D have the same time?
   (Both points are on the same meridian. The Sun is at the Noon point over these two places at the same time.)

6. Why would you have to re-set your watch as you traveled East or West?
   (The Sun would be at the Noon point at a different time in your new location.)

7. When railroads were established in this country, it became possible to travel great distances in relatively short times.

8. Why did the railroads find it difficult to publish schedules of all their stops?
   (Every town was on a different time.)

9. Display the time-zone map of the U.S.A.
How did the railroads solve this problem?
(They divided the country into four time zones.)

10. Indicate that all locations within a time zone have the same local time, regardless of the position of the Sun. There is a one-hour difference between adjacent time zones, and the time gets earlier as you go West. Give students a time in New York and have them determine the concurrent time in California.

11. If you travel from New York to Chicago, how must you re-set your watch?
(One hour back.)

12. How do you re-set it if you go from California to New York?
(Three hours ahead.)

13. Indicate a place where the dividing line between two zones bends to avoid going through the middle of a state or city.

14. Why is this arrangement better than a straight dividing line?
(If it were straight, people would have to re-set their watches when they went from one part of the city [state] to another.)

15. Display the time-zone map of the World. Have students note that there are 24 time zones, each one approximately 15 degrees wide (360 degrees/24 = 15 degrees) and each one representing an hour's difference in time. Some areas, such as Newfoundland and India, use half-hour divisions.

16. Indicate the Prime Meridian (0 degrees) and have the students count the time zones west to New York.
If it is 5:00 P.M. in England, what time is it in New York? (Noon)

17. If it is 5:00 P.M. Tuesday in England, where is it twelve hours earlier?
(Students should indicate the 180 degree line in the Pacific.)

18. Indicate the time here as 5:00 A.M. Tuesday.
Where is it twelve hours later (5:00 A.M. Wednesday)?
(Students should recognize this as the same zone they indicated before.)

19. Display Figure 2.
Why do you need a special dividing line in the middle of the Pacific?
(This line divides one day from another.)

20. This line is the International Date Line. The area west of this line is one day later than the area east of it. Travelers who move westward across this line must advance their calendars one day, while those who move eastward must turn their calendars back.

Summary:

Have students examine the World map. If it is 3:00 (or any given time) in New York, what time is it in the following places?

1. England
2. France
3. Argentina
4. Alaska
5. Mexico
6. China

Application:

If you worked for a company in New York, and you had to call a company in Los Angeles, why would you have to wait at least until Noon? (Because it would be 9:00 A.M. Pacific Time. If you tried any earlier, there might not be anyone in the office.)

Assignment:

1. What is a solar day?

2. How does the time of day change as you move eastward?

3. How does the day change as you move westward across the International Date Line?

Fig. 1

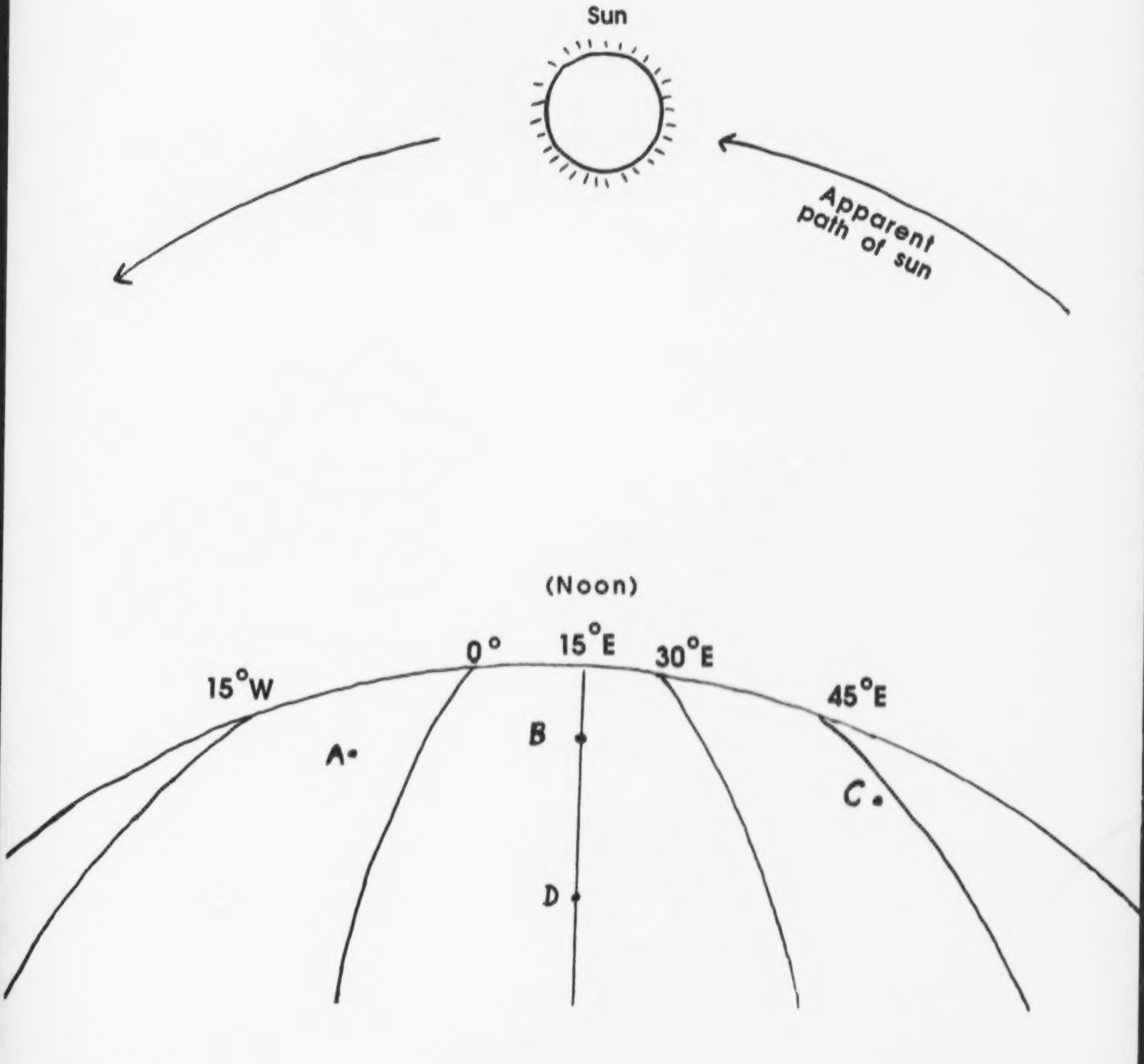
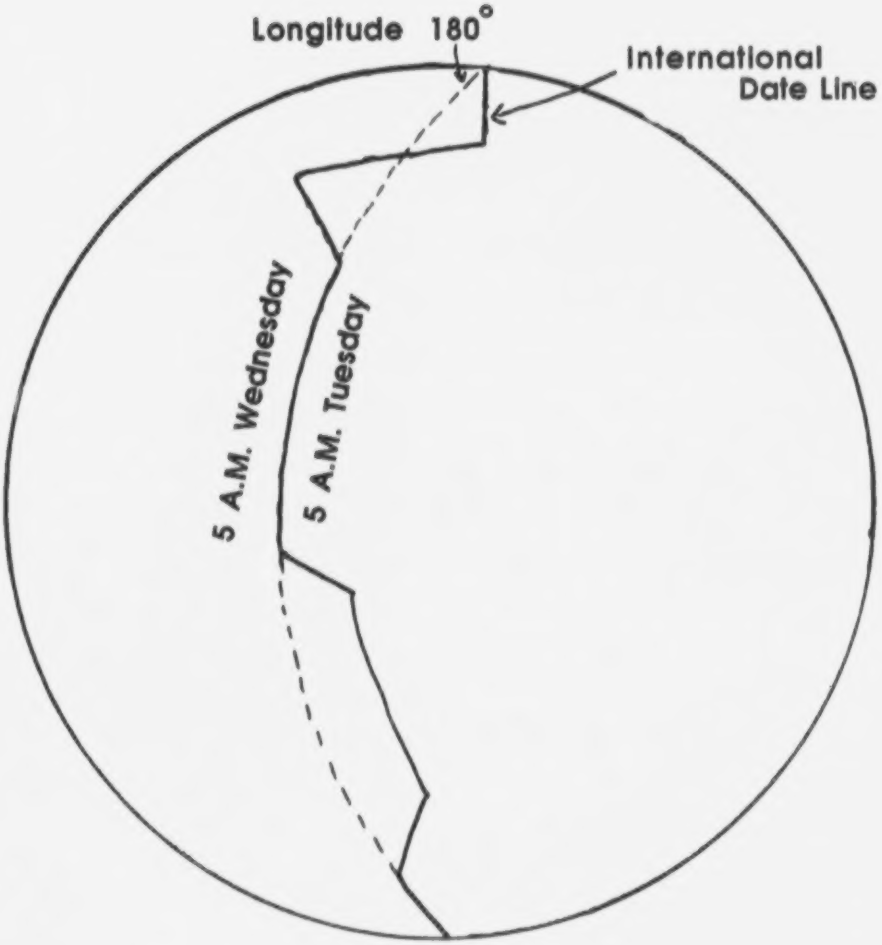

Sun
Apparent path of sun
(Noon)
15°W
0°
15°E
30°E
45°E
A
B
C
D

Fig. 2


Longitude 180°
International
Date Line
5 A.M. Wednesday
5 A.M. Tuesday

TOPIC 30 - Time Zones (Computer Lab)

Aim: How does the time of day differ in other areas of the World?

Performance Objectives: Students will be able to:

- identify the time of day on a certain continent given a time zone map
- use the International Date Line to determine the day in a given location

Materials:

- computer Lab with 16 Apple computers
- 16 copies of the program WORLD CLOCK (Compress)
- class set of worksheets

Motivation:

Explain to the class that if they know the time in New York, they can determine the time anywhere in the world, using this program.

Development:

1. The WORLD CLOCK program requires that the user type in a certain TIME. (day, month, date, year, hour, minute) In this lesson, two such times will be used. Put the following on the board:

   1. Sunday, September 21, 1986, 3:01 P.M.

   2. Saturday, June 21, 1986, 11:30 P.M.

   In the first part of the exercise, the first time shown above will be used. In the second part, the second time will be used.

2. Distribute the program disks to each group of students and have them boot up their systems. When the Main Menu is displayed, have them press 3 for WORLD CLOCK. The screen will clear and the following message will appear:

```
PLEASE ANSWER THE FOLLOWING QUESTIONS IN
ORDER TO START THE PROGRAM WORLD CLOCK.

             (Screen Clears)

      ENTER DAY (Enter 1 for Sunday)
      ENTER MONTH (Enter 9 for Sept.)
      ENTER DATE (Enter 21)
      ENTER YEAR (Enter 1986)

             (Screen Clears)
```

ENTER THE HOUR OF THE DAY (Enter 3)
ENTER THE MINUTE OF THE HOUR (Enter 1)
FOR AM ENTER 1, FOR PM ENTER 2 (Enter 2)

PRESS RETURN TO START.

4. Upon pressing RETURN, a map of the World will appear, with even numbers on the bottom to indicate the hour in alternate time zones. The day, date, month and year entered will be shown at the bottom of the screen, along with a digital display of the hour, minute and second. The hour entered --in this case 3 o'clock--will appear on the map as Eastern Standard Time.

(Note: This program can be customized to show the hour entered in other locations. Instructions for customizing are contained in the Main Menu Entry #4.)

5. Dark bands will show the areas of the World that are in darkness at that hour. If the program is allowed to run for a sufficient length of time, the bands will shift to the right when the hour changes.

6. Have the students examine the map and do Part I of their worksheets. When they are through, they should turn off the computers and immediately turn them on again. This will re-boot the system and recall the Main Menu.

7. Students should press 3 for WORLD CLOCK, But this time they should enter the second time (Saturday, June 21, 1986, 11:30 P.M.)

8. Allow the students time to answer Part II of their worksheets.

9. At the end of the lesson, students should shut down their systems.

Summary:

Conduct an oral review of the questions on the worksheet. If time permits, students could set the WORLD CLOCK to a date and time of their own choosing and fill out an additional worksheet according to the map that is displayed.

Assignment:

1. Why does the time get later as you travel East?

2. Why is there no apparent difference in the time of day in New York City and Lima, Peru even though these two cities are thousands of miles apart?

3. If it is 2:00 A.M. in one place, what time is it in a place exactly halfway around the World ? (Assume that the time zones are even.)

GRADE 8 (Earth Science)
Unit V,A. Lesson 8a

STUDENT'S NAME________________________ CLASS ____________ DATE _________

WORKSHEET

Part I:

Base your answers to the questions in this part on the WORLD CLOCK display for Sunday, September 21, 3:01 P.M. Answer them by writing the letter of the correct choice.

___ 1. As you go West on this map, the time of day
a. gets earlier c. remains the same
b. gets later d. It is impossible to tell.

___ 2. As you go North, the time
a. gets earlier c. remains the same
b. gets later d. It is impossible to tell.

___ 3. It is 12 Noon in
a. The American West c. South America
b. Africa d. China

___ 4. It is 12 Midnight in
a. Alaska c. Greenland
b. India d. Australia

___ 5. In New York it is afternoon. The time of day in Europe is
a. morning c. evening
b. Noon d. just before sunrise

___ 6. The day in Australia is
a. Saturday c. Monday
b. Sunday d. It is impossible to tell.

Part II:

Re-set your WORLD CLOCK to Saturday, June 21, 11:30 P.M., as per the instructions given by your teacher. Answer the following questions in complete sentences.

1. How is the pattern of daylight and darkness different on this day than on September 21?

2. Why does northernmost part of the World have 24 hours of daylight on this day of the year?

TOPIC 31 - Telescopes and Artificial Satellites

Aim: How can we collect data from the stars?

Performance Objectives: Students will be able to:

- explain the difference between radio telescopes and optical telescopes
- contrast the nature of data collected by each type of instrument

Materials:

Small telescope, two magnifying lenses, concave mirror, diagram or model of reflecting telescope, pictures of radio telescopes and large optical telescopes, spectrum chart showing radio waves, pictures of artifical satellites.

Motivation:

Scientists have discovered many things about the stars that cannot be seen, even with a telescope. Elicit the question: How could they discover things that cannot be seen?

Development:

1. Demonstrate the magnifying power of the two lenses by holding them in line in front of the class. Display a picture of a large refracting telescope, along with the small one on the front table. Have students note that this instrument also has two lenses.

2. Why was this such an important invention for astronomers?
(It enabled them to see heavenly objects that were too dim or distant to be seen with the naked eye.)

3. Display a model or diagram of a reflecting telescope.

4. How is this telescope different from the first one?
(This telescope has mirrors instead of lenses.)

5. Explain that reflecting telescopes can be made much larger than refracting telescopes. These two types of telescopes are called optical telescopes.

6. Why can these telescopes only be used on clear nights?
(The Sun and clouds obscure the light from the other heavenly bodies.)

7. Display the spectrum chart. Explain that the Earth is constantly being bombarded by all these rays from Space.

8. Why do most of these rays never reach the Earth?
(The atmosphere either absorbs or reflects them.)

9. Identify the visible rays and radio waves as two types of rays that do reach the Earth.

10. Why can't we detect radio waves with optical telescopes?
    (Radio waves are invisible.)

11. Display pictures of radio telescopes. These are used to detect radio waves from Space. Radio waves are not stopped by air, clouds or sunlight.

12. Why is this type of telescope more useful than an optical telescope?
    (Radio telescopes can be used 24 hours a day, regardless of the weather.)

13. Explain that there are other types of telescopes that detect infra-red (heat) rays and X-rays.

14. Why are these telescopes useless on Earth?
    (The rays that they record are unable to pass throught the atmosphere.)

15. Display photographs of artificial satellites. The first one was launched in 1958.

16. Why has this enabled us to learn much more about space than before?
    (A satellite can carry instruments out of Earth's atmosphere. Once there, they can detect rays that cannot reach the ground and send this data down to Earth.)

Summary:

Have students write how each of the following has increased our knowledge of the Sun, stars and planets;

1. Optical telescope

2. Radio telescope

3. Artificial satellite

Application:

The Moon is the only heavenly body that has been visited by humans. Why did the astronauts leave instruments behind when they visited the Moon?

Assignment:

1. Why are radio telescopes more useful than optical telescopes?

2. How is a reflecting telescope different from a refracting telescope?

3. Why must scientists use artificial satellites to detect X-rays and infra-red rays?

TOPIC 32 - The Moon and the Tides

Aim: What is the relationship between the motions of the moon and the tides?

Performance Objectives: Students will be able to:

- describe the relationship between the time of moonrise/moonset and the phase that the students observe
- determine the length of time that occurs from one full moon to the next
- calculate the time when the moon reaches its highest point in the sky
- observe and describe the relationship between the motions of the moon and the pattern of tides

Materials:

- An almanac or daily newspaper which contains daily tide tables and the daily time of moonrise and moonset.
- Computer equipped with a printer, spreadsheet software.

Motivation:

- Place the following questions on the board and ask the students to answer them based upon their personal observations.

1. When does the moon rise?

2. When does the moon reach its highest daily altitude?

3. When does high tide occur (remind the students that they experienced tidal changes when they were at the beach).

4. When does low tide occur?

Development:

This lesson is not designed for completion during a single class period. Use the class period to introduce the activity and provide direction so that the students can perform the long-term investigation and collect their data through personal observations and independent research. After 1 month (1 lunar cycle of phases) has passed have the students bring their data to class and use a computer equipped with spreadsheet software to complete the calculations which are required.

1. Call upon several students and elicit from the students that the moon does not rise and set at the same time every day. Also use the students responses to the "do now" questions to elicit from the students that the time of high tide varies.

Challenge the students to develop an explanation for these variations in time of moonrise/moonset and tidal patterns.

2. Distribute the rexographed table and instruct the students how they can obtain the required information. Show the students where the information is contained within a newspaper or almanac. Challenge the students to develop a method for learning which phase is visible on a specific day. If the students have difficulty in this, remind them that they can observe the moon and draw a sketch of the phase using their own observations. The students can use the information on the time of moonrise/moonset to determine when the moon will be visible.

3. Instruct the students on techniques that can be used to learn the times of the daily high and low tides. Be sure the students understand that they can obtain the data by personal observations. Demonstrate the way that this information can be obtained using daily tide tables published in a newspaper or almanac.

4. Advise the students that they must collect data for both clear and cloudy days. Suggest that they draw sketches of the phases only on days when they can actually observe the moon and write "cloudy" on days when the moon cannot be seen.

After this long-term investigation has been introduced, be sure that the students understand they must collect the data daily for the entire duration of the investigation. Tell the students that they will be using the computer to make calculations and use the computer to observe relationships between the moon's observed motions and the daily tides.

Computer Activity: This activity can be performed using any type of computer lab and any spreadsheet software. Because of differences in the operation of the different programs it is necessary that the teacher become familiar with the software being used before allowing the students to perform this activity.

1. Instruct the students that they should insert the diskette into the drive, close the door, and follow the procedures necessary to boot up the program. Some programs may require the use of a DOS diskette.

2. Instruct the students to convert all time data into the 24-hour clock format. Demonstrate how this can be done by adding 12 hours to every time recorded that is 1:00 P.M. or later.

3. Provide the students with the list of titles for their spreadsheet program and instruct them on the technique that is used to enter this material into the program.

4. Challenge the students to develop formulae for calculating the time that the moon reaches its maximum altitude and a formula for determining the elapsed time between one high tide and the next. Depending on the student achievement levels you can use the spreadsheet to calculate other relationships.

5. Show the students how to enter the data and perform their calculations.

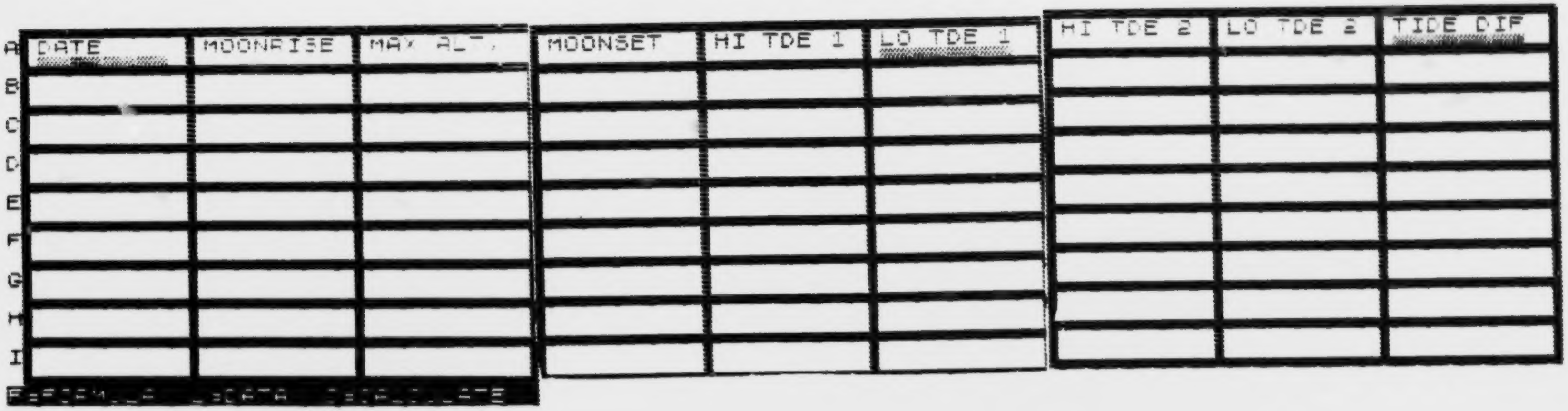
6. If the computers are equipped with printers, have the students print hard copies of the completed spreadsheet.

Summary:

At the completion of the entire long-term investigation, repeat the same questions that were originally presented to the students.

Homework:

The homework associated with this activity is the daily observation and sketching of the moon's phase and the research necessary to obtain data for the rexographed chart.



A	DATE	MOONRISE	MAX ALT.	MOONSET	HI TDE 1	LO TDE 1	HI TDE 2	LO TDE 2	TIDE DIF
B									
C									
D									
E									
F									
G									
H									
I									

F=FORMULA D=DATA C=CALCULATE

Sample of rexographed data sheet - Moon Activity

Date	Time of moonrise	Time of moonset	Phases (sketch)	High tides		Low tides	

TOPIC 33 - Planetary Orbits

Aim: How can we determine the shape of a planet's orbit?

Performance Objectives: Students will be able to:

- describe the relationship between a planet's distance from the sun and its orbital velocity
- explain why the length of a year varies on each planet (period of revolution)
- explain how Johannes Kepler helped us to understand the observed motions of the planets
- describe why the velocity of a planet in orbit varies
- explain why a planet moves fastest when it approaches perihelion and moves slowest at aphelion
- describe the relationship between the velocity of a planet and the pull of gravity

Materials:

Rexographed sheet containing data on the motions of the planets, colored chalk.

Computer Activity: Apple II computer lab, Astrolab-Planetary Orbits software by Alan Crowe. Published by Edutech Inc.

Motivation:

Draw a circle on the chalkboard and label it "Sun". Draw a planet several feet from the Sun and then call upon a student to draw a line representing the path or orbit that the planet will follow as it travels around the Sun. (Use various colors to assit students in understanding the diagram).

Tell the class that the position of the planet represents its position in orbit on the date during which you are conducting the lesson. Call upon another student to come up to the chalkboard and point out where the planet "Earth" will be in exactly one year. Introduce the concept that the year is the period of revolution of a planet.

Development:

Based upon the student-drawn diagram, demonstrate the elliptical shape of orbits. Introduce Johannes Kepler and explain how Kepler discovered that the planets followed elliptical orbits. Be sure to emphasize the fact that Kepler utilized data provided by the famous astronomer Tycho Brahe.

1. Place Kepler's three laws of orbital motion on the chalkboard and draw the diagram (on next page) Use this diagram to assist the students in developing an understanding of Kepler's laws.

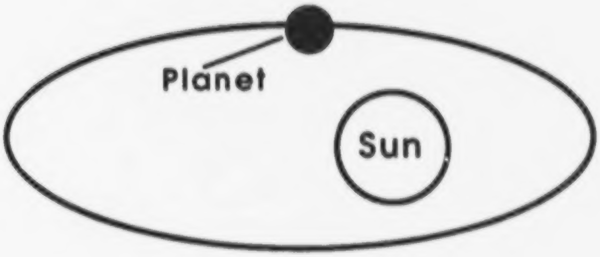


diagram 1

a. Kepler's First Law - Law of Orbits
The orbits of planets are ellipses with the Sun at one focus.

b. Kepler's Second Law - The Law of Equal Areas
A line (imaginary) connecting a planet to the Sun sweeps over equal areas of space in equal periods of time.

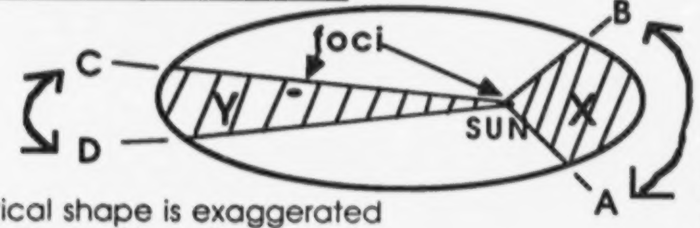
c. Kepler's Third Law - The Square of the Period of Revolution of a Planet is Proportional to the Cube of the Average Distance from the Sun.
This law is a mathematical relationship which connects a planet's period of revolution with its distance from the Sun.

2. Depending upon the achievement level of the students, you may introduce the students to the formula P2 = D3. Place the formula on the chalkboard and explain to the students that P represents the period of revolution of a planet in earth years and D represents the average distance between astronomical units. (1 AU = the average distance between the Earth and the Sun - 93,000,000 miles or 250,000,000 km).

Demonstrate the application of this relationship using data for the planet Mercury. Period of revolution = 88 days (.24 earth years) average distance from sun = .39 Astronomical Units.

(.24)2 ~ (0.39)3

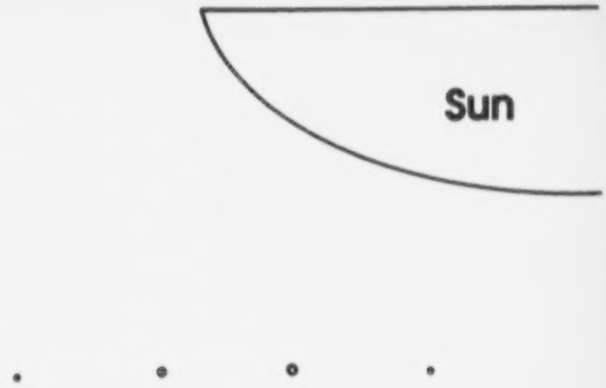
diagram of a planet's orbit



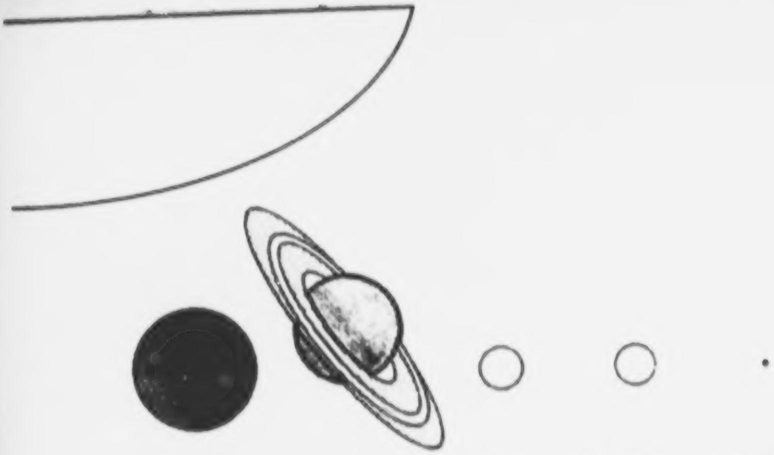
area x =
area y

The time it takes for a planet to move from A to B is equal to the length of time it takes to move from C to D

the elliptical shape is exaggerated
to show the position of the 2 foci



	MERCURY	VENUS	EARTH	MARS
MAXIMUM DISTANCE FROM SUN (MILLIONS OF KILOMETERS)	69.7	109	152.1	249.1
MINIMUM DISTANCE FROM SUN (MILLIONS OF KILOMETERS)	45.9	107.4	147.1	206.7
MEAN DISTANCE FROM SUN (MILLIONS OF KILOMETERS)	57.9	108.2	149.6	227.9
MEAN DISTANCE FROM SUN (ASTRONOMICAL UNITS)	.387	.723	1	1.524
PERIOD OF REVOLUTION	88 DAYS	224.7 DAYS	365.26 DAYS	687 DAYS
ROTATION PERIOD	59 DAYS	-243 DAYS RETROGRADE	23 HOURS 56 MINUTES 4 SECONDS	23 HOURS 56 MINUTES 23 SECONDS
ORBITAL VELOCITY (KILOMETERS PER SECOND)	47.9	35	29.8	24.1
INCLINATION OF AXIS	<28°	3°	23° 27'	23° 59'
INCLINATION OF ORBIT TO ECLIPTIC	7°	3.4	0	1.9°
ECCENTRICITY OF ORBIT	.206	.007	.017	.093
EQUATORIAL DIAMETER (KILOMETERS)	4,880	12,104	12,756	6,787
MASS (EARTH = 1)	.055	.815	1	.108
VOLUME (EARTH = 1)	.06	.88	1	.15
DENSITY (WATER = 1)	5.4	5.2	5.5	3.9
OBLATENESS	0	0	.003	.009
ATOMOSPHERE (MAIN COMPONENTS)	NONE	CARBON DIOXIDE	NITROGEN, OXYGEN	CARBON DIOXIDE, ARGON (?)
MEAN TEMPERATURE AT VISIBLE SURFACE (DEGREES CELSIUS) S = SOLID, C = CLOUDS	350(S) DAY -170 (S) NIGHT	-33 (C) 480 (S)	22(S)	-23 (S)
ATMOSPHERIC PRESSURE AT SURFACE (MILLIBARS)	10^{-9}	90,000	1,000	6
SURFACE GRAVITY (EARTH = 1)	.37	.88	1	.38
MEAN APPARENT DIAMETER OF SUN AS SEEN FROM PLANET	1°22'40"	44'15"	31'59"	21'
KNOWN SATELLITES	0	0	1	2
SYMBOL	☿	♀	⊕	♂



JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
815.7	1,507	3,004	4,537	7,375
740.9	1,347	2,735	4,456	4,425
778.3	1,427	2,869.6	4,496.6	5,900
5.203	9.539	19.18	30.06	39.44
11.86 YEARS	29.46 YEARS	84.01 YEARS	164.8 YEARS	247.7 YEARS
9 HOURS 50 MINUTES 30 SECONDS	10 HOURS 14 MINUTES	-11 HOURS RETROGRADE	16 HOURS	6 DAYS 9 HOURS
13.1	9.6	6.8	5.4	4.7
3 05'	26 44'	82 5'	28 48'	?
1.3°	2.5°	.8°	1.8°	17.2°
.048	.056	.047	.009	.25
142,800	120,000	51,800	49,500	6,000 (?)
317.9	95.2	14.6	17.2	.1 (?)
1,316	755	67	57	.1 (?)
1.3	.7	1.2	1.7	?
.06	.1	.06	.02	?
HYDROGEN, HELIUM	HYDROGEN, HELIUM	HYDROGEN, HELIUM METHANE	HYDROGEN, HELIUM METHANE	NONE DETECTED
- 150 (C)	-180 (C)	-210 (C)	-220 (C)	-230 (?)
?	?	?	?	?
2.64	1.15	1.17	1.18	?
6'09"	3'22"	1'41"	1'04"	49"
13	10	5	2	0
♃	♄	⛢	♆	♇

3. Computer Activity: After the students have developed an understanding of the relationship between a planet's distance from the Sun, its velocity, use the computer to assist the students in developing an understanding of planetary orbits. NOTE - THIS PROGRAM MAY NOT BE SUITABLE FOR UNDERACHIEVERS.

   a. Instruct the students to place the diskette into the drive and close the drive door. Remind the students that they must not bend the diskette or touch the exposed recording media. After the drive doors are closed, instruct the students to turn on the monitors and computers. The program is self-booting and will provide the students with an introductory screen (allow at least 20 minutes for this activity).

   b. The program will plot the motion of a planet orbiting around the Sun. The students have the option of plotting the orbits of the real planets (data contained within the program or an imaginary planet if they can supply the mass, perihelion, eccentricity of orbit.

Summary:

At the conclusion of the computer activity instruct the students to remove the diskettes and place them in the protective envelopes. Remind them to shut the drive doors and then turn off the computers and monitors. While the diskettes are being collected, instruct the students to answer these question:

1. Why does a planet move faster at perihelion?

2. What causes a planet to slow down as it travels away from the Sun?

3. Draw a diagram demonstrating the shape of a planetary orbit.

Homework:

1. What is an astronomical unit?

2. What is the average distance from the Earth to each of the 8 other planets in astronomical units?

3. Using the data from question #2 - evaluate the period of rotation of each of the planets. What is the length of a year on each of the planets?

(see chart on previous pages)

TOPIC 34 - Planetary Movements

Aim: How do planets move across the sky?

Performance Objectives: Students will be able to:

- describe the observed motion of planets across the night sky
- explain why planets often exhibit retrograde motion when observed for prolonged periods of time
- explain why planets often exhibit changes in apparent diameter when observed over extended periods of time
- explain how the observed motions were originally explained using a geocentric model of the solar system
- explain how the observed motions are explained using the heliocentric model of the solar system

Materials:

- Motivation - flashlight and chalkboard
- Computer activity
  a. Apple Computer lab and Skylab (software) by M.E.C.C.

Motivation:

1. Shine a flashlight onto the blackboard from approximately 2 feet back. Have a student come up to the board outlining the size of the lighted area.

2. Step back several more feet and repeat the procedure. The circle of light will appear larger.

3. Explain to the students that when planets are observed in the night sky (generally with a telescope), the size of the planet (its apparent diameter) appears to change over an extended period of time.

4. Challenge the students to develop possible explanations for the change that occurs in the observed size of the planet.
   Be sure the students understand the relationship between the apparent diameter and the distance between the earth

Development:

1. Introduce the word "planet" and explain that this word came from the Greek word for "wanderer." Challenge the students to explain why "wanderer" may be an appropriate description of a planet.

2. Draw the diagram on the board and explain that the planets often appear to move east to west (like the stars), but over an extended period of time can also appear to move backwards when compared with the stars. Introduce the term "retrograde motion."

3. Challenge the students to develop a possible explanation for this observed motion. Introduce the concept of the geocentric solar system (historical model) and guide the students to understand that attempts were made to explain this motion using epicycles or small circles in

the orbit of the planet. Be sure that the students understand that this model was accepted only until the 1700's and we now know that the solar system is heliocentric.

Computer Activity: Apple Computer Lab

1. Turn on the monitor and computer after inserting the diskette into the drive.

2. This program is self booting and will provide the students with a menu. This program contains several options- all of which can be used for teaching the motions of celestial objects. They are: rotation, revolution, revolving planets, and Halley's Comet.

3. Instruct the students to select "Revolving Planets"

4. The program displays the constellations of the zodiac and also shows the relative positions of the planets as they orbit around the sun. To demonstrate retrograde motion have the students select Mars. The graphics will demonstrate the way that both the Earth and Mars orbit around the sun.

5. From "Revolving Planets" the students have the option to select additional features from a submenu. Instruct the students to select the "backyard" option. This will give the students the opportunity to observe the position of the planet in the night sky - as viewed from a backyard. The graphics draw the view of the night sky - including the constellations. It gives the compass direction and month during which the planet can be observed in this location. This program allows the students to go back to the "Revolving Planets" feature so that they can see the actual position of the planets in space and then equate this with the observed position of the planet in the night sky.

6. This software package also contains excellent documentation which contains technical data about planetary motions, worksheets for student use, and suggestions for class activities after using the program. This material is well-suited for a non-science teacher that is teaching astronomy.

Summary:

Why do planets exhibit retrograde motion?

a. Challenge the students to write a short paragraph or draw a diagram which explains why the planets may appear to move backward when compared with the stars.
b. Why do the planets appear to change in size? (apparent diameter)

Homework:

Historical reports

1. How does the heliocentric model of the solar system differ from the geocentric model?
2. What was Copernicus' contribution to astronomy?

TOPIC 35 - Comets, Meteors and Asteriods

Aim: How do comets, meteors, asteroids and planetoids travel through the solar system?

Performance Objectives: Students will be able to:

- describe the characteristics of each of these celestial objects: comets, meteors, and asteroids
- explain how each of the above named objects travels through the solar system
- describe the way that each of the above named objects appears when it is observed from the earth
- explain how telescopes are constructed and used to observe celestial objects

Development:

1. Do Now Activity - Place the following vocabulary words on the blackboard and instruct the students to use their glossaries or dictionaries to define the words.

2. After the students are familiar with the new vocabulary and can read the new words, introduce the computer activity.

3. Instruct the students to take the diskettes and place them into the disk drives without touching the magnetic recording surface.

4. Instruct the students to close the disc drive doors, turn on the monitors and then turn on the computers. The program will self-boot and present the students with a title screen and then a menu.

5. This program provides the students with 5 options:
   a) asteroids b) meteors c) lesser comets d) Halley's comet e) telescopes

The program is designed to provide the students with a text selection and graphics. After the students have had the opportunity to read the appropriate material, the students are given a series of questions on the topics. The students are directed to answer the multiple choice questions by typing and entering the appropriate number. If the student selects a correct answer, the computer provides positive reinforcement and goes on to the next question. If the student selects an incorrect answer, the computer returns to the appropriate screen and gives the student the opportunity to reread the selection. When the student has completed the reading and is ready to go on, the return key is pressed and the computer returns to the question that was originally answered incorrectly. The program gives the student several opportunities to try and select the correct answer.

6. This program is written on a level which makes it appropriate for elementary and intermediate school students. The students can start with the first selection and work through the entire program independently. In addition, the program can be used to teach individual topics. If you choose to teach an individual topic such as the "telescope",instruct the students to select that topic from the menu and to stop working when they have completed reading that selection and have answered all of the appropriate questions.

7. Time limits: Allow at least 15 minutes for the students to read and operate each of the individual selections. If you desire, you can instruct the students to copy the questions and write the answers in their notebooks. This will provide the students with written material which can be used to study for tests, or to assist the students in completing their homework assignments.

Summary:

Present the students with a series of questions based upon the selection(s) which you assigned in class.

Sample questions:

1. Why does Halley's comet only appear in the sky every 76 years?

2. What is the structure of a comet?

3. Name the major parts of a comet and describe the appearance of each part.

4. How do comets travel through the solar system?

5. Draw a diagram of Halley's Comet and label all of the parts.

Homework:

1. Assign the students a group of vocabulary words depending upon the selection(s) utilized in class. Assign the students to define any new words (not defined in class) and to use each word in a sentence.

TOPIC 36 - Stellar Movements

Aim: How do the stars appear to move across the celestial sphere?

Performance Objectives: Students will be able to:

- describe the motions observed if stars are observed for a prolonged period of time
- explain why stars in the northern sky appear to circle around Polaris (the North Star).
- describe how specific stars can be located using azimuth and altitude as a coordinate system.
- explain why the stars appear to move from east to west at a uniform rate of 15 degrees per hour.

Materials:

- Motivation - A slide or photograph showing a time exposure of the northern sky.
- Computer activity - IBM or Tandy computer lab, DOS, "Skyplot" software (public domain-available from the Public Domain copying Company-N.Y.C.), wax pencils and soft paper tissues.

Motivation:

Display the photo or slide and challenge the students to explain how it was taken. Elicit from the students that the picture resulted from the camera being held stationary while the stars moved across the night sky.

Development:

Introduce the concept of the constellation and guide the students to understand that constellations are distinctive patterns of stars that are observed from the earth. Draw Casseiopia on the board and explain how constellations can be identified by their distinctive shapes.

1. Instruct the students to insert the DOS diskette into the drive and turn on both the monitor and computer.

2. Tell the students that when the "A" prompt appears they should remove the DOS diskette and insert the program diskette. After the diskette has been placed into the drive, the students should close the drive door and type the program name "SKYPLOT." The students should then strike the "Enter" key.

3. The program will appear on the screen and instruct the students to enter the date (at which they wish to observe the night sky),the LMT (local mean time), longitude and latitude, the time zone (N.Y. is zone 5), and the direction which you wish to observe.

4. After the data is entered, the program will plot the night sky as it will appear during the date and time specified. The stars appear as points of light and the positions of the planets are indicated by the use of capital letters ("J" indicates Jupiter)

A. Instruct the students to view the night sky for the date when you are conducting the lesson. Have the students enter the longitude and latitude of N.Y.C. (longitude 74.00, latitude 40.45). Enter time zone 5, and enter 20:00 for the Local Mean Time (using the 24-hour clock 8 P.M.=20:00)

After the data is entered, instruct the students to view the northern (N) sky.

B. The program will draw the northern sky as it should appear at 8 P.M. The altitude and azimuth coordinates will appear as number scales along the sides and bottom of the screen.

   1. To familiarize the students with the concept of azimuth and altitude, have them determine the coordinates of stars and constellations which have previously been introduced. They can determine the coordinates of specific stars in Casseiopia or the coordinates of Polaris (the last star in the handle of the "Little Dipper".

C. Instruct the students to take their wax pencils and make marks on the CRT (video) screen over these specific stars. The students can also place marks over the positions of other distinctive star patterns.

   1. Instruct the students to return to the menu and view the same section of the sky at 20:30 hours (8:30 P.M.), 21:00 hours (9 P.M..), 21:30 (9:30 P.M.), and 22:00 hours (10 P.M.). Instruct the students to place marks over Polaris during each time interval (screen) being viewed.

      a. What pattern of star motion occurs in the northern sky?
      b. How do the stars appear to move in relation to Polaris?
      c. Why does Polaris remain stationary in the northern sky?
      d. How far do the stars appear to move in one hour?
      e. How does the motion of the stars compare to the revolution of the earth on its axis?

   2. Instruct the students to take the soft tissue and wipe the wax pencil marks off the screens. Then have the students repeat the exercise viewing the eastern, southern, and western skies during the same time intervals. The students can repeat the wax pencil procedure to determine the pattern of motion that appears in each direction.

      a. How do the stars appear to move in the eastern, southern, and western skies?
      b. How does the motion of a star compare with the observed motion of the sun? (remind students that the sun rises in the east and sets in the west)
      c. Why do stars in the western sky appear to sink below the horizon?

Summary:

At the completion of the star observation activity challenge the students to describe the path that a star appears to take as it moves across the sky. Emphasize that the stars appear to move in arcs, from east to west at a steady speed of 15 degrees per hour.

Challenge the students to explain why Polaris appears to remain stationary while the other stars in the northern sky appear to move in arcs around it.

How is this observed pattern related to the earth's revolution?

Homework:

Instruct the students to go outdoors and observe the northern sky at 8 P.M. If the sky is clear the students should be able to identify constellations that were observed on the computer screen. Instruct the students to draw a diagram of the stars that they observed. Tell them to repeat their observations again at 9 PM. How do the sky observations differ from the stars represented on the computer screen?

Appendices

Categorical Glossary of Computer Technical Terms

MEMORY

BIT	The smallest unit of information a computer processes.
BYTE	A byte is 8 bits long.
KILOBYTE	1024 bytes of information (memory capacity of a computer.
MAIN MEMORY	The internal storage device of the computer.
MEGABYTE	1,048,576 bytes of information (notes size of memory.
REGISTER	Very fast memory locations found in the central processing unit.

LANGUAGE

BASIC	A programming language for beginning programmers.
COBOL	Common Business Oriented Language.
FORTRAN	(Formula Translation) computer language used by scientists.
LANGUAGE	A set of words or symbols used to give instruction to a computer.
MACHINE LANGUAGE	The only language understood directly by a computer which is composed of binary numbers. Each type of computer has its own machine language.

HARDWARE

ACOUSTICAL COUPLER	A modem which connects a computer terminal to a telephone handset and changes computer signals to signals that can be sent over a phone line.
ANALOG COMPUTER	A computer that works with a continuous scale or measure.
CARD PUNCH	A device which punches holes in a card to represent data.

CARD READER	An input device which senses hole patterns in a punch card and translates them into computer data.
CENTRAL PROCESSING UNIT (CPU)	The part of the computer that interprets instructions and carries them out.
CHIP	A small bit of silicon upon which an integrated circuit is built.
ELECTRONIC COMPUTER	A machine that stores and processes information using electrical and magnetic signals.
CONTROLLER	A device that moves information between a disk and the main memory so the C.P.U. can use it.
DIGITAL COMPUTER	A computer that works with a measure of distinct values.
DISK	A flat circular plate with a magnetic surface layer upon which data can be stored.
DISKETTE	A secondary storage device with a magnetic surface for reading.
DISK DRIVE	A device that plays disks or diskettes.
DIRECT CONNECT MODEM	A modem that connects directly to a phone line.
FIRST GENERATION COMPUTER	Computers that use vacuum tubes.
GRAPHIC DIGITIZER	A graphic input device that changes lines on paper into coordinates that are automatically fed into the computer.
GRAPHIC TABLET	A kind of graphic digitizer where a stylus is used to draw on an electronic tablet.
GRAPHIC TERMINAL	T.V. monitor.
HARDWARE	The physical equipment of a computer.
INPUT/OUTPUT DEVICES	Devices which move data into and out of the main memory of a computer.
INTEGRATED CIRCUIT	A chip of silicon that performs the same function as transistors, capacitors and resistors.
LIGHT PEN	A graphic input device which is light sensitive.
LINE PRINTER	A device that prints a line of characters as a unit.
MECHANICAL PLOTTER	A graphic output device, uses pen to draw on paper.

	paper.
MICROCOMPUTER	A computer that has a microprocessor as its C.P.U.
MICROPROCESSOR	A tiny silicon chip that is the central processing unit of a computer.
MODEM	Changes computer signals into tones that can be carried on telephone lines.
ONLINE TERMINAL	A terminal connected to a computer where data may be entered on telephone lines.
PERSONAL COMPUTER	Table top computer which has a microprocessor as its central processing unit.
PERIPHERAL DEVICES	External devices that can extend a computer's capabilities.
PLOTTER	A graphic output device, draws with pen and ink on paper.
SECONDARY STORAGE DEVICE	Supplementary, external data storage (disk)
SECOND GENERATION COMPUTER	Computers that use transistors, capacitors, and resistors.
TAPE DRIVE	Audio tape recorder used to store computer programs and data.
TERMINAL	A device with a keyboard and display to send and receive information from a computer.
TRANSISTOR	A small semi-conducting device that performs the functions of a vacuum tube.
THIRD GENERATION COMPUTERS	Computers that use integrated circuits or silicon chips.
VIDEO TERMINAL	A terminal with a T.V. screen.
WORD PROCESSOR	A computer used to manipulate written material.

PROCESS

ACCESS	To get a record.
ADDRESS	A number for a location in the computer's memory.
ALGORITHM	A procedure for solving a problem.
BATCH PROCESSING	Gathering information and entering it into a computer all at once.

BENCHMARK RUN	A test run of a program to judge its performance.
BRANCH	To select one of several possible acts of instructions in the execution of a computer program.
BUG	An error.
CHARACTER	A letter or symbol used to represent data.
CODING	A way of shortening data so that it will take fewer memory locations.
COMPILER	A program that changes a computer program written in another language such as Fortran or Cobol, into machine language.
COMPUTER SCIENCE	The study of theories of computation.
DATA	The information that is put into a computer to be processed by a program.
DATA PROCESSING	Taking information and changing it into other useful forms.
DIGIT	Arabic numerial 0 - 9.
DIRECT ACCESS FILES	Files from which records may be taken in any order.
EXECUTE	To perform or carry out.
FEEDBACK	The use of output from input to make the system self correcting.
FILE	A set of related records stored together and treated as a unit.
FIELD	A certain area of a record used for a particular piece of data (age, name).
FIELD TEST	The testing of a computer program on a small scale to correct errors before it is widely distributed.
HARD COPY	A printed copy of machine output.
INFORMATION	Organized data used in a computer program.
INPUT	Information given to a computer.
KEY	The portion of a record used to determine where a record goes in a file.
LOOP	A set of instructions that may be executed

	repeatedly while a certain condition exists.
MENU	Similar to a table of contents in a book.
OPERATING SYSTEM	A program that controls the execution of computer programs.
OPERATION	A basic function of a computer (addition, subtraction movement of data).
OPERATION CODE	The portion of machine language that tells the computer what operation to perform.
OUTPUT	The information generated by a computer.
POWER	The speed and storage capacity of a computer.
PROCESS	A systematic order of operation to produce a certain result.
PROGRAM	The instructions that tell a computer what to do.
QUANTIFICATION	The changing of data to measurable quantities.
RECORD	A collection of related data treated as a unit (payroll).
SEQUENTIAL FILES	A file of information which can only be read record by record.
SIMULATION	The development of a model for the purpose of testing a theory.
SOFTWARE	Computer programs.
SUBROUTINE	A self-contained set of instructions used by a program or another subroutine.
SYNTAX ERROR	An error generated by improper input.
SYSTEMS ANALYSIS	Procedures for systematic study of the structure of a system to improve it.
TIME SHARING	The use of a computer by more than one person at a time.
VARIABLE	A part of the program that is changeable.

HISTORY

Howard Aiken - Developed the Mark I mechanical computer.

John Atanosoff and Clifford Berry - Experimented with the first electronic computer (used vacuum tubes).

Charles Babbage - Designed a calculating machine called the analytical engine.

Presper Eckert - Developed ENIAC, a first generation computer, with John Mauchly.

Herman Hollerith - Developed a punch card system for the census.

Joseph Marie Jacquard - Used punch cards to control looms.

Gottfried Wilhelm Von Leibnitz - Created an early multiplying and dividing machine.

John Von Neumann - Proposed that computers use the binary number system and stored programs.

Blaise Pascal - Created early adding and subtracting machine.

CAREERS

Customer Engineer - A technician who makes sure a computer works properly.

Field Service Engineer - A technician who will travel to a company to fix its computer.

Operations Personnel - Personnel who are directly responsible for making the computer usable.

Systems Analyst - One who studies a system and suggests ways to improve the system.

Systems Programmer - One who creates operating system and languages for the computer.

Caring for Your Diskettes

Your computer diskettes will provide years of dependable service if you and your students handle them properly by following a few simple procedures.

1. Never handle a diskette unnecessarily. When it is necessary to touch a diskette, hold it by the corner near the label, and touch as little of its surface as possible. Under no circumstances should you ever touch the interior magnetic recording surface, either through the center of the diskette or any other opening in the diskette cover.

2. Never bend or fold a diskette.

3. Whenever possible, write out the diskette label before affixing it to the diskette. If it is necessary to write on the label after it has been affixed to the diskette, always use a felt tipped pen or marker. Never write on the diskette with a pencil or ball point pen.

4. Never attach anything to a diskette with a paper clip of any kind.

5. When a diskette is not in use, always return it to its paper envelope. Store it in a cool, safe place, away from direct sunlight, excessive heat, moisture, dust, and dirt of any kind.

6. Computer diskettes are magnetic, and any contact with other sources of magnetism can destroy the programs and files that are stored on them. Keep your diskettes away from magnets of any kind, no matter how harmless they seem to be. Magnetic desktop paper clip holders (a principal source of trouble because they aren't obvious), magnetic children's toys and so forth can damage your diskettes no matter how harmless they appear to be. In addition, many common electric and electronic appliances are sources of magnetism. Televisions, radios, electric lights, and even the screen of your computer monitor produce minute amounts of magnetism which can cause diskette damage. Store your diskettes away from these devices when they are not in use, and do not allow your diskettes to come into contact with them when you are using them.

7. Never attempt to clean a diskette with cloth or fluid.

8. Always write protect your important diskettes by covering the notch in the left side with tape. This will keep you from accidentally erasing or overwriting an existing program or file.

9. Finally, accidents that ruin or erase diskettes are bound to happen. Learn how to use the diskcopy and copy commands on your DOS, and, as a precaution, always make backup copies of any diskettes you would find difficult or impossible to replace.

Copying Public Domain Diskettes

Like plays, novels, songs, textbooks, and all other published material, the programs and files on a published computer diskette are fully protected by the copyright laws of the United States. No diskette can legally be copied without the appropriate permission of the publisher. The position of the Office of Technology of the New York City Board of Education on diskette copying is clearly stated in the June, 1986 issue of COMPUTALK:

1. Duplication of copyrighted software or documentation is prohibited.

2. Software publishers must be contacted to verify procedure for backup multiple copies and licensing agreements.

3. A publisher's written permission is required to download or network programs to other microcomputers.

4. No student or Board of Education employee may use school computers to duplicate copyrighted software.

5. The use of illegally duplicated software, however obtained, is prohibited in all Board of Education facilities.

6. Simultaneous use of original software and/or its back-up is not permitted without the written permission of the publisher.

Although the New York City Board of Education does not have computer diskettes under contract at this time, New York City schools can order diskettes through companies that have been awarded New York State Supply contracts. If you wish to purchase additional diskettes, the Office of Technology suggests that you contact:

Kilobytes Incorporated
80 Davids Drive
Hauppauge, N.Y. 11788
(516) 231-1800
contract number P23590

The item number for flexible diskettes size 5 1/4 inches is MD00505. The description is 1 sector (soft sector, and the price is $5.50 per box of ten.

Copying Public Domain Diskettes for the Apple IIe and Apple II Plus

To make a copy of your public domain or data diskette, follow these steps:

1. Before proceeding, be sure that the diskette you wish to copy is write protected. Write protecting your diskette will prevent you from accidentally erasing or overwriting any of its programs or files during this or any other use of the diskette. You can write protect a diskette by placing a small piece of tape over the write protect notch on the diskette's left side.

2. Insert the DOS 3.3 System Master diskette into drive 1 and turn the computer and the monitor on. When the Applesoft prompt and cursor appear type in RUNCOPYA and press RETURN.

3. The screen will display the message

```
APPLE DISKETTE DUPLICATION PROGRAM
ORIGINAL SLOT:   DEFAULT = 6
```

   Press RETURN.

4. The screen will display

```
ORIGINAL SLOT: 6
       DRIVE:    DEFAULT = 1
```

   Again, press RETURN.

5. The screen will display

```
       DRIVE: 1
```

   and add a new message:

```
DUPLICATE SLOT:  DEFAULT = 6
```

   Press RETURN.

6. The screen will display

```
DUPLICATE SLOT: 6
```

   and ask one last question:

```
       DRIVE:    DEFAULT = 2
```

   If you are using an Apple II Plus or IIe with one disk drive, change the number 2 to 1 and press RETURN. If your machine has two disk drives, simply press RETURN. The screen will display

```
-- Press `RETURN' key to Begin Copy --
```

7A. If you are using a computer with two disk drives, the screen will give you no further instructions. Remove the DOS 3.3 System Master diskette and insert the source diskette into drive 1. (The source diskette is the diskette you want to copy.) Insert the target diskette into drive 2.

(NOTE: It is not necessary to format a new diskette before using it as the target diskette. The Apple II Plus or IIe will format it automatically before copying onto it.)

Press RETURN. Reading and Writing messages will appear alternately as the computer reads the source diskette and writes onto the target diskette. If the target diskette has not been formatted before, the screen will also display Formatting.

B. If you are using a computer with a single disk drive, press the RETURN key. You will have to alternately insert and remove both the source diskette and the target diskette during the copying procedure. The screen will tell you what to do at the proper times. Follow its instructions carefully. When you insert the target diskette for the first time, the screen will display the word Initializing while it proceeds.

When the screen displays the message

```
DO YOU WISH TO MAKE ANOTHER COPY?
```

the procedure is over; the target diskette has been made into a duplicate of the source diskette.

8. If you want to make another copy of the source diskette, type in Y and press RETURN. The screen will repeat the message

```
-- Press `RETURN' key to Begin Copy --
```

You can repeat this procedure as many times as necessary and make as many copies of your original public domain or data diskettes as you need. When you no longer wish to make additional copies, press N and remove the source diskette from drive A.

Copying Public Domain Diskettes for IBM/Tandy

To make a copy of a public domain or data diskette on an IBM PC, PCjr, or IBM compatible Tandy computer with a single disk drive, follow these steps:

1. Before you start, be sure that the diskette you wish to copy is write protected. Write protecting a diskette will prevent you from accidentally erasing or overwriting any of its programs or files. You can write protect a diskette by placing a small piece of tape over the write protect notch on its left side.

2. Insert the IBM DOS diskette into the disk drive, turn the computer and the monitor on, wait for the DOS to boot up, then enter the date and time. The last line on the screen will be A>.

3. Type Diskcopy, then press ENTER. The screen will display the message,

```
Insert SOURCE Diskette in Drive A :
Press any key when ready . . .
```

   The SOURCE diskette is the diskette you want to copy. Remove the DOS diskette from the disk drive and insert the Source diskette. Press ENTER.

4. The screen will display a Copying . . . message, then the following instructions:

```
Insert TARGET Diskette in Drive A :
Press any key when ready . . .
```

   The TARGET diskette is the diskette you want to copy to. Remove the source diskette from the disk drive and insert the Target diskette. (NOTE: It is not necessary to format a new diskette before using it as the target diskette. Diskcopy will format automatically before copying.) Press ENTER.

5. If your target diskette has not been formatted before, the screen will display a Formatting . . . message before it copies. After it has formatted and copied, it will repeat the message it gave you in step 4:

```
Insert SOURCE Diskette in Drive A :
Press any key when ready . . .
```

   Remove the target diskette from the disk drive and insert the source diskette again. Press ENTER.

6. After another Copying . . . message, the screen will repeat the message from step 5:

```
Insert TARGET Diskette in Drive A :
Press any key when ready . . .
```

   Again, remove the source diskette from the disk drive and insert the target diskette. Press ENTER.

7. This is the last stage of the procedure. When the screen displays the message

    ```
    Copy another diskette (Y/N)?
    ```

    the procedure is over; the target diskette has been made into a duplicate of the source diskette.

8. If you want to make another copy of the source diskette, type in Y. The screen will repeat the message

    ```
    Insert SOURCE Diskette in Drive A :
    Press any key when ready . . .
    ```

    You can repeat this procedure as many times as necessary and make as many copies of your original diskettes as you need for use in the New York City Public Schools. When you no longer wish to make additional copies, press N and remove the source diskette from drive A.

Diskcopy with Two Disk Drives

Copying on an IBM PC or IBM compatible Tandy with two disk drives is an even easier procedure, because it doesn't require alternately removing and inserting the source and target diskettes. Follow the directions for steps 1 and 2 for a computer with one disk drive, then type in Diskcopy A: B: at step 3 and press ENTER. The screen will display this message:

```
Insert SOURCE Diskette in Drive A :
Insert TARGET Diskette in Drive B :
Press any key when ready . . .
```

Remove the DOS diskette, insert the source and target diskettes into the proper disk drives and press any key on the typewriter keyboard. The screen will display a copying . . . message while it copies the source diskette and a formatting . . . message if the target diskette hasn't already been formatted. When the screen displays the message

```
Copy another diskette (Y/N)?
```

the procedure is over; the target diskette has been made into a duplicate of the source diskette. If you want to make another copy of the source diskette, type in Y and repeat the procedure.

For More Help

The Office of Technology maintains a Technical Assistance Center (TAC) in each of the five boroughs. These centers are equipped with a wide variety of computers, software, and, most important, experienced advisors to help you use the computers in your school more effectively and to answer any questions about computer education you may have. All New York City Public School teachers are welcome to make use of TAC facilities, either by telephone or in person, at any time during the year. TACs are normally open from 9 A.M. to 5 P.M. during the school year and through all school vacations, including the summer, but daily hours can vary. Call first.

Bronx TAC
1000 Teller Avenue
Bronx, N.Y. 10456
(212) 588-0279

Brooklyn TAC
3000 Avenue X
Brooklyn, N.Y. 11235
(718) 769-2860

Manhattan TAC
134 West 122 Street
New York, N.Y. 10027
(212) 662-0122

Queens TAC
167-01 Gothic Drive
Jamaica, N.Y. 11432
(718) 658-0491

Staten Island TAC
1200 Manor Road
Staten Island, N.Y. 10314
(718) 494-5042

List of Software Used in This Text

This list contains all of the software mentioned in this text. The New York City Board of Education in no way recommends any piece of included software. It is the intent of this book to suggest different ways that software can be used to enhance the instructional process and not to recommend any specific software package. There are many graphics packages which are available which can perform the same functions as those named herein.

As with any classroom material, it is recommended that software be tested before it is used with students.

Continental Drift Lab Pack	Prentice-Hall	13-7078.03.X
Crossword Magic	Mindscape	60-9400.12.6
Experiments in Science	Human Relations	91-4133.12.8
** Exploring Matter	D.C. Heath	*
Forecast!	CBS Software	03-8505.00.2
Moisture in the Atmosphere	IBM	90-4124.86.X
Water and Weather	Focus Media Inc.	60-4550.09.X
** Weather and Forecasting	Prentice-Hall	13-7046.44.8
World Clock	Compress	60-4510.08.X

* ISBN number not available

** This software is pending approval as of the publication date of this book (February 1, 1987)